RESTRICTIVE TRADE
PRACTICES COMMISSION

Telecommunications in Canada

Part III
The Impact of Vertical Integration on the Equipment Industry

RESTRICTIVE TRADE PRACTICES COMMISSION

TELECOMMUNICATIONS IN CANADA

PART III

THE IMPACT OF VERTICAL INTEGRATION ON THE EQUIPMENT INDUSTRY

Report in the Matter of an Inquiry under section 47 of the Combines Investigation Act relating to the Manufacture, Production, Distribution, Purchase, Supply and Sale of Communication Systems, Communication Equipment and Related Products

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RESTRICTIVE TRADE PRACTICES COMMISSION

TELECOMMUNICATIONS INQUIRY

Member	R.S. MacLellan, Q.C.
Member	F. Roseman

Restrictive Trade Practices Commission
Commission sur les pratiques restrictives du commerce

January 7, 1983

The Honourable André Ouellet, P.C., M.P.
Minister of Consumer and Corporate Affairs
House of Commons
Ottawa, Ontario
K1A 0A6

Dear Sir:

I have the honour to transmit to you, on behalf of Dr. Roseman and myself, the French and English texts of the third and final part of a report entitled "Telecommunications in Canada - Part III - The Impact of Vertical Integration on the Equipment Industry." Mr. L.-A. Couture, Q.C., who served as Chairman of this inquiry until his retirement, has been given the opportunity to read this report, and he is in full agreement with it.

The present report follows from an inquiry carried out under section 47 of the Combines Investigation Act relating to the manufacture, production, distribution, purchase, supply and sale of communication systems, communication equipment and related products.

Yours very truly,

R.S. MacLellan, Q.C.
Commissioner

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CHAPTER I

INTRODUCTION

This is the third part of a three-part report on telecommunication equipment. Part I, submitted September 10, 1981, dealt with the issue of interconnection policy and the equipment associated therewith - i.e., the various terminals used by consumers of telecommunication services. Part II was submitted July 26, 1982 in response to the proposed reorganization of Bell Canada. Part III is concerned with the equipment areas that comprise the telecommunication network. The central issue is that of vertical integration, in particular the relationships of Bell Canada and B.C. Tel with their affiliated equipment suppliers, Northern Telecom and AEL Microtel, respectively.

Vertical integration is undoubtedly the critical determinant of the market position of suppliers in this industry. The industry structure has also been shaped to some extent by the tendency of some carriers to favour suppliers with plants in their areas. This is a factor that appears to be of some importance in the purchase of wire and cable and also, in Manitoba, of telephones. The effect is to increase the number of plants over the number that would be justified by the economics of production and transportation. More usual factors such as economies of scale and tariffs tend to have effects which oppose each other. To the extent that tariffs permit higher prices to be maintained, an umbrella is provided for less efficient producers, while the benefit of lower unit cost encourages the establishment of larger firms and plants.

The background evidence on market shares of suppliers and that relating to particular sub-categories of telecommunication equipment are discussed in Chapter II. Other evidence from suppliers relating to complaints is discussed in a later chapter.

The position originally taken by the Director in the Green Book and in the Opening Statement was that the divestiture of Northern Telecom from Bell Canada was necessary. The Director has not pursued this recommendation in his final argument.

The probable effect on Northern of divestiture was dealt with in the expert testimony of two witnesses from Price Waterhouse & Co. There are two aspects to the evidence of these witnesses. The first is that divestiture would not be very harmful nor, in the opinion of senior market analysts whom they interviewed, have a significant impact on Northern's position. The second aspect of the evidence, and the more lengthy part of it, dealt with the feasibility of divestiture from a financial viewpoint, having regard to fairness to the existing shareholders. The latter evidence would only be relevant in the event that the Commission should conclude that divestiture was a desirable course of action.

A number of Northern witnesses have provided considerable detail on its performance. This evidence is presented in Chapter III. Evidence on this matter, introduced by the Director, has primarily dealt with instances where Northern might be considered to have failed in its ventures. As has been stressed by Northern and Bell, the ultimate test of Northern's performance should be its ability to compete in open markets. This, in the Commission's view, is an appropriate test and one which Northern has passed very well.

Performance must also be evaluated at the level of the delivery of services. Bell expends resources in support of Northern's efforts. The amount and pattern of development and equipment expenditures might differ if Bell were dealing with a number of suppliers at arm's length. The Director, in addressing this topic, has relied primarily on the testimony of Dr. Robert Babe, an expert witness, which dealt with comparisons of his measurement of productivity change in Bell, B.C. Tel and the Prairie telcos. Bell offered a number of narrower comparisons of Bell's performance relative to that of other telcos in Canada and in other countries. A discussion and an evaluation of this evidence are presented in Chapter III. The evidence is mixed and inconclusive, particularly since vertical integration is only one of a number of factors that affect performance. It does not justify divestiture.

The policy options which remain address the issue of whether to open up the Bell market to some degree. These options relate to the types of equipment which Bell buys, and secondly to the identity of firms to whom the Bell market should be made accessible. At the heart of these considerations is the precise way in which vertical integration works to provide Bell with the products produced by Northern. Extensive testimony has been provided by Bell/Northern and their jointly owned enterprise, Bell-Northern Research, on how this process works. A central tenet of the Bell/Northern position is that it would be impossible to open up any part of Bell's purchasing of telecommunication equipment without having a harmful effect on the development and manufacture of products by Northern. The Bell-BNR-Northern relationship is also presented in Chapter III.

A section on Bell's proposed reorganization concludes Chapter III.

There follows in Chapter IV a discussion of the relationship between B.C. Tel and its newly purchased equipment supplier, AEL Microtel Limited, which formerly was wholly owned by B.C. Tel's majority shareholder, GTE. B.C. Tel has filed with its regulator, the Canadian Radio-television and Telecommunications Commission (CRTC), a set of procurement practices and has stated that these practices are a formalization of previous purchasing policies and should not provide any advantage to the equipment supplier owned by B.C. Tel. B.C. Tel and the Director have taken the position in final argument that Bell, too, could engage in the purchase of equipment without favouring Northern Telecom. It is, therefore, essential that the relationship between B.C. Tel and AEL on the one hand, and Bell and Northern on the other, be fully explored so that the two situations can be appreciated.

The purchasing policies of the non-integrated telecommunication firms in Canada are discussed in Chapter V. Conditions under which there should be access to Bell and B.C. Tel are very much related to the state of telecommunication markets world-wide. For this reason the markets in other countries are reviewed in Chapter VI. There is an important distinction to be drawn between the non-vertically integrated telcos in Canada and telcos in other countries. The telcos in other countries represent much larger units, which are extensions of government and are instruments in effecting national development policies. Although the telcos on the Prairies are government owned and are to some extent instruments of provincial development policy, the considerable difference in the size of these telcos and in the jurisdiction of the governments on the Prairies and those in other countries makes the situations not comparable.

Chapter VII deals with the evidence of representatives of suppliers who claimed that they had been denied access to the Bell market because of Bell's relationship with Northern, even though they had a less expensive or a better product. There are relatively few substantiated claims (the criteria are strict), with none made specifically against B.C. Tel. This chapter is intended, along with the review of the evidence on performance in Chapter III, to capture the possible costs of vertical integration. The results do not suggest a serious current problem, but neither do they indicate that the potential problems of vertical integration can be ignored.

The final chapter discusses the policy issues which have arisen in the course of the inquiry and sets out the following recommendations.

1. Northern should be required to continue to sell to Bell at prices which are no higher than those offered to other Canadian customers.

2. Bell and B.C. Tel should be required to file with the CRTC comparisons of prices they pay to their manufacturing subsidiaries for selected equipment items and those that are available from other suppliers in Canada and the U.S.A.

3. a) B.C. Tel should maintain its procedures for open procurement.

   b) Bell Canada must show itself more receptive to innovations which are developed in Canada by non-affiliated companies.

4. There should be increased co-operation among provincial regulatory bodies and the CRTC in order to enable more effective comparisons of telco performance.

5. The Government should provide guidelines to the CRTC on the weight to be attached to the value of vertical integration in furthering national goals in the event that the CRTC should find that vertical integration is costly to the subscriber.

CHAPTER II

TELECOMMUNICATION EQUIPMENT SUPPLIERS

1. Distribution of Shares of Overall Sales

Telecommunication equipment falls into three broad categories - central office equipment, station apparatus and outside plant. Table 1 shows expenditures by the principal telecommunication carriers in Canada in 1977. The expenditures by equipment category provide only a rough indication of the distribution of equipment expenditures because the labour cost entailed in installing equipment is included with the cost of equipment. It is known that capitalized labour costs accounted for roughly 25 per cent of the total expenditures of $1,721.2 million, but labour cost for each equipment category is not known.* Total expenditures on equipment net of the labour component were $1,290.9 million.

Northern's sales of communication equipment in Canada in 1977 were $1,014 million. This included "sales" of R&D to Bell and others by Bell-Northern Research Ltd. (BNR), and the sales by Nedco Ltd.,** which distributed

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* Within the category of station apparatus, station connections have a large labour content.

** Nedco did make some sales to telephone companies and an estimate of their volume has been included in Northern's sales. NBTel in 1976 and 1977 made purchases from Nedco equal to about 1.5 per cent of its purchases from Northern. If this was a typical pattern, Nedco made sales to telcos of somewhat more than $12 million in 1977.

TABLE 1

PLANT EQUIPMENT EXPENDITURES BY PRINCIPAL CANADIAN TELECOMMUNICATION COMPANIES

	1975	1976	1977
		($ millions)	
Central Office Equipment			
Switching: Manual	14.1	6.4	7.0
Step-by-Step	89.5	101.9	93.0
Crossbar	140.0	144.0	160.3
Electronic	179.3	239.5	240.8
Transmission: Radio	60.7	63.4	60.0
Other	218.0	186.0	188.6
Sub-Total	701.5	741.3	749.7
Station Apparatus			
Teletypewriters (includes cathode ray tubes)	22.4	14.9	15.5
Telephones & misc.	124.2	122.5	129.5
Radio Telephones	19.7	17.8	20.2
Data	16.5	16.1	19.1
Station Connections	170.5	190.0	226.4
Large PBX	58.7	57.6	59.0
Sub-Total	412.0	418.9	469.6
Outside Plant			
Pole Lines	20.7	24.5	42.8
Cable: Aerial	111.2	126.5	149.3
Underground	78.5	97.8	89.3
Buried	98.1	111.1	141.7
Submarine	1.1	.6	1.1
Aerial Wire	3.5	3.7	7.3
Underground Conduit	62.4	65.1	70.3
Sub-Total	375.5	429.3	501.8
Total	1,489.1	1,589.5	1,721,2

SOURCE: *The Principal Canadian Telecommunications Carriers: Expenditures on Telecommunications Equipment 1973-1982*, Department of Communications.

electrical and electronic products. When these sales are subtracted, Northern's sales to telecommunication carriers are $822 million,* representing 64 per cent of their purchases. This undoubtedly is an underestimate of Northern's market share in equipment areas where it has products. Within the equipment categories shown in Table 1, Northern did not produce teleprinters, radio telephones and, with minor exceptions, data terminals in the area of station apparatus, nor line poles and underground conduit in the outside plant category. When purchases of these products by the telecommunication carriers are subtracted, total purchases are reduced to $1,193.5 million and Northern's share is increased to almost 69 per cent.

This estimate compares with a statement, in a prospectus issued October 7, 1975 by Northern Electric Company, Limited, that "[Northern] sells to all segments of the Canadian telephone operating company market and believes that it has in excess of 70% of this market." In a prospectus issued by Northern Telecom Limited on September 13, 1979, it is again stated that it has about 70 per cent of the market for the types of products manufactured by it. It also states that:

> "Other major telecommunications equipment manufacturers, including subsidiaries of GTE and International Telephone and Telegraph Corporation ('ITT'), which manufacture such equipment in Canada, as well as small, highly specialized manufacturers, compete for sales to Canadian telephone operating companies including Bell Canada."

Apart from the adjective "small" - which does not properly apply to the wire and cable firms, Canada Wire and Cable Limited and Phillips Cables Limited, and, since the statement was made, to the supplier of PBXs and integrated circuits, Mitel Corporation - this is an accurate overall description of telecommunication equipment suppliers in Canada.

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* Northern's exports were $77 million in 1976.

Sales by the British Columbia Telephone Company affiliates, GTE Automatic Electric (Canada) Ltd. and GTE Lenkurt Electric (Canada) Ltd., in 1977 totalled $166 million. However, a major part of the sales by Automatic consisted of products for which Automatic acted as a distributor. When these are excluded, sales totalled $137.4 million, or roughly 11.7 per cent of the 1977 purchases* by major telecommunication carriers.

Information on the sales of suppliers to telecommunication carriers is also available from surveys of major telecommunication carriers carried out by the Director of Investigation and Research for the years 1969 and 1975. Table 2 shows the information on purchases by telecommunication carriers made from various suppliers in 1975.** Northern's share of sales in this survey is 61.4 per cent and the combined share of Automatic and Lenkurt is 12.5 per cent. These figures differ from those posted earlier because they are based on all equipment categories and not, as in the case of Northern, on just those which it produced; Automatic's sales include its sales as a distributor. Despite minor errors and omissions, Table 2 provides a useful overview of how the telecommunication companies divide their purchases.

Purchases by telecommunication carriers from Northern, Automatic and Lenkurt in 1975 are shown in

---

* Excludes estimated capitalized labour and pole lines and underground conduit.

** Total expenditures by the carriers were $1,084 million, which is fairly close to estimated expenditures on equipment in Table 1, of $1,117 million, after the removal of estimated capitalized labour.

TABLE 2

TELECOMMUNICATION EQUIPMENT SALES TO CANADIAN TELEPHONE COMPANIES - 1975

($ millions)

	Northern Telecom	Automatic Electric	Lenkurt Electric	Phillips Cables	Canada Wire and Cable	A.E.I.	ITT	CGE	Farinon	Canadian Motorola	LM Ericsson	Vidar	Plessey	Other	Total Purchases
AGT	64.7	5.1	13.2	10.7	5.5	4.5	3.3		*	3.4		1.6		9.5	121.5
Bell Canada	449.2													98.8	548.0
B.C. Tel	9.9	66.7	15.3			*		1.4		.2		1.5		24.4	119.4
CNT	6.2	1.7						3.0	1.8					17.3	30.0
CPT	.8						.1	.1						11.6	12.6
Teleglobe	.2		.2					.2			.7			7.5	8.8
'edmonton telephones'	15.9	1.9		1.8	1.0	2.4	1.1	.1					.1	2.0	26.3
Island Tel	4.5		.6			.3				.2	.3			.3	6.2
MTS	17.3	1.1	3.3	1.6	4.3	.8	1.3	1.0	.6		1.3			10.3	42.9
MT&T	27.5	1.2	3.7	2.2		.6		.2	.3	.6	.5			2.3	39.1
NBTel	13.6	.2		.3	1.1		.5	.1	.1		.3			6.2	22.4
Newfoundland Telephone	11.2(1)	.9							.7		.3			2.8	15.9
Northern Tel	2.3	.8					.2						.5	3.9	7.7(3)
Okanagan		4.1	.2			.6	.3							1.1	6.3
Québec-Téléphone	11.5(1)	5.4	1.9					.5	.6		.6			1.1	21.6
Sask Tel	30.3	4.3	3.5	1.3	5.2	1.5	1.8		.6					6.1	54.6
Thunder Bay Utilities	.4	—	—	—	—	—	—	—	—	—	—	—	.1	.4	.9
Total Sales by Supplier	665.5	93.4	41.9	17.9	17.1	10.7	8.6	6.6	4.7	4.4	4.0	3.1	.7	205.6	1,084.2
Market Share of Supplier	61.4%	8.6%	3.9%	1.7%	1.6%	1.0%	.8%	.6%	.4%	.4%	.4%	.3%	.07%	18.9%	100.0%(2)

SOURCE: Returns of Information of telecommunication companies.

* Significant purchases, but total not specified.
(1) Includes purchases from Nedco (1975) Ltd.
(2) Because of rounding, figures may not add to exactly 100%.
(3) Not including repair.

TABLE 3

PERCENTAGE DISTRIBUTION OF PURCHASES BY TELECOM CARRIERS FROM NORTHERN, AUTOMATIC AND LENKURT

	1969			1975		
	Northern Electric %	Automatic Electric %	Lenkurt Electric %	Northern Electric %	Automatic Electric %	Lenkurt Electric %
Bell Canada	89.03	-	-	81.97	-	-
B.C. Tel	4.23	64.55	11.27	8.29	55.86	12.81
Okanagan	15.38	46.15	-	-	65.08	3.17
MTS	34.69	5.10	12.24	40.33	2.56	7.69
Sask Tel	30.29	18.86	22.29	55.49	7.88	6.41
'edmonton telephones'	24.10	31.33	-	60.46	7.22	-
AGT	54.49	10.96	5.98	53.25	4.20	10.86
MT&T	56.18	3.37	11.24	70.33	3.07	9.46
NBTel	62.63	1.01	-	60.71	.89	-
Island Tel	25.00	-	12.5	72.58	-	9.68
Newfoundland Telephone	80.95	4.76	-	70.44	5.66	-
CNT	1.21	-	-	20.67	5.67	-
CPT	1.25	-	-	6.35	-	-
Teleglobe	3.57	-	-	2.27	-	2.27
Northern Tel	69.57	13.04	-	29.87	10.39	-
Québec-Téléphone	46.75	33.77	14.29	53.24	25.00	8.80
Thunder Bay Utilities	50.00	-	-	44.44	-	-

SOURCE: Table 2.

Table 3, which is based on the information in Table 2. There are several patterns which stand out in Table 3. The preference for the equipment of affiliated suppliers in the case of Bell and B.C. Tel is unmistakable. The large share of purchases from Northern by the Atlantic telcos, which have ownership relations with Bell, could be the result of a preference being shown to Northern. This has been strongly denied by representatives of all the telcos concerned. Another factor which may explain the results, at least in part, is the location of a number of Northern's facilities in the Atlantic Provinces. Automatic and Lenkurt had relatively more success in selling to the Prairie telcos than to those in the Atlantic Provinces, with the exception of MT&T, with whom Lenkurt was very successful. An Automatic or Lenkurt plant is located in each of the Prairie Provinces. Another point that emerges from Table 3 is that between 1969 and 1975 Northern increased its sales to the telcos at the expense of Automatic, a result due to Northern's success in the development of switching technology.

2. Tariffs and Imports

Domestic production of telecommunication equipment has been protected by relatively high most-favoured-nation (MFN) tariffs. British Preferential rates are lower, however, the MFN tariff affects most firms which are likely to export to Canada. Although most applicable MFN rates are falling, as shown in Table 4, the tariff for Electric Telephone Apparatus (Item No. 44508-1) has not changed recently. This helps counter the fact that many countries have government-owned telephone administrations whose procurement policies foster their domestic industry.

Figures for 1976 showing wire and cable production and imports are in evidence before the Commission. In that year imports of telephone cable and telephones, radio and TV wire were approximately six per cent of the value of shipments of goods of own manufacture reported by Statistics Canada for these categories. Aggregated figures for 1976 showing the domestic market, shipments,

TABLE 4

MOST-FAVOURED-NATION TARIFF*

Item	Item #	1977	1982	1987
			(per cent)	
Telephone Wire Single, Coated or Covered	40122-1	15.0	13.2	10.2
Telephone Cable	40123-1	17.5	14.8	10.2
Electric Telegraph Apparatus and Complete Parts Thereof	44506-1	17.5	14.8	10.2
Electric Telephone Apparatus and Complete Parts Thereof	44508-1	17.5	17.5	no change indicated
Radio and Television Apparatus and Complete Parts Thereof	44533-1	15.0	12.8	9.2

SOURCE: Customs Tariff, effective January 1, 1982, Departmental Consolidation.

* The British Preferential Tariff is currently 10 per cent on 40122-1; 12.5 per cent on 40123-1; free on 44506-1 and 44533-1; 10 per cent on 44508-1.

exports and imports for the telecommunication sub-sector of the electronics sector are shown in Table 5. The trade balance in this sub-sector compares very favourably with that for the electronics sector as a whole, and with the trade balance for manufacturing activity in Canada.

TABLE 5

ELECTRONICS SECTOR, TELECOMMUNICATION SUB-SECTOR* 1976

TRADE BALANCE

	($ millions)
Domestic Market	512
Shipments	506
Exports	89
Imports	95
Trade Balance	-6

SOURCE: *A Report by The Sector Task Force on The Canadian Electronics Industry.*

* Excludes radio communication equipment, radar, defence and space communication equipment (mobile transceivers, earth stations, etc.) which are reported in a separate sub-sector.

3. Suppliers Represented at the Inquiry

The telecommunication equipment industry consists of a number of equipment categories and, in some cases, what amounts to separate industries from the point of view of product development, manufacturing capability and customer needs. This fact may be obscured by the existence of a firm such as Western Electric in the United States that provides for almost all of the needs of

AT&T. Northern also supplies a very broad range of products to Bell and to other telcos, with the exception of a few product areas in which it is not active. In general, suppliers of telecommunication equipment which do not have favoured access to a major telco tend to be specialized, and to cater to a wider customer base than is provided by telcos, or even by telecommunication users. Telco demand from unaffiliated suppliers is not sufficient by itself to support the existing number of telecommunication equipment suppliers. In spite of the large, combined share of telecommunication equipment sales by Northern and the GTE companies, Automatic and Lenkurt, a large number of manufacturers of telecommunication equipment appeared as witnesses before the Commission.

Many of the firms represented at the inquiry, which are listed below in Chart I, were described in Part I of this Report. These firms are identified by an "I". Only those firms supplying telecommunication equipment in addition to terminals are covered in Part III. With the exception of the broad-line multinational telecommunication equipment suppliers, the firms are grouped according to their main product line marketed in Canada. Included in the first group are producers of central office switches. Their equipment is the most sophisticated in the telecommunication system, and it requires the largest firm size, both at the product development and production stages. Except for Northern and GTE, none of the firms are currently effective suppliers of switches in Canada. Although earlier vintages of switches were sold by Plessey Canada Limited and LM Ericsson Limited, these suppliers never made sufficient sales to justify full assembly operations, and for the most part provided installation and back-up services. As noted in Part I, in the case of telecommunication equipment, ITT Canada Limited, LM Ericsson, Philips Electronics Ltd., and Plessey were primarily suppliers, or would-be suppliers, of terminal equipment in Canada. Siemens Electric Limited supplies switching equipment for data and telex networks to CNCP, and is also a supplier of terminal equipment.

CHART I

EQUIPMENT MANUFACTURERS REPRESENTED IN THE INQUIRY

Firm	Principal Telecommunication Products Sold in Canada	Telecom. Equipment Sales Size Group*	Percentage of Total Sales Derived from Telecom Equipment
Broadline Suppliers Including Central Office Switching			
LM Ericsson Limited (I)	subscriber apparatus (crossbar PBX's, intercoms, private exchanges), rural switches	B	47
Automatic Electric (I) (AEL Microtel)	telephone sets, digital PBX's, analogue and digital central office switches, distributed products	E	98
ITT Canada Limited (I)	telephone sets, key telephone systems, subscriber loop concentrators, telegraph equipment	D	6
Philips Electronics Ltd. (I)	telephone answering equipment, intercom equipment	B	3
Plessey Canada Limited (I)	electronic KTS/PBX, telex switches	B	79
Siemens Electric Limited (I)	data switches, non-voice terminal equipment, PBX's	B	33
Northern Telecom (I)	full line supplier	E	83
Transmission Products			
GTE Lenkurt (AEL Microtel) (I)	analogue and digital multiplex, light route microwave radio, supervisory and control equipment for microwave routes (the System 51)	D	80

*The Groups refer to the following annual sales volumes (the figures used were from 1976 and 1977 and, in a few cases, from 1978).

A	under one million
B	$ 1 M to $ 7.9 M
C	$ 8 M to $ 19.9 M
D	$ 20 M to $ 49.9 M
E	over $ 50 M

CHART 1 (continued)

Firm	Principal Telecommunication Products Sold in Canada	Telecom. Equipment Sales Size Group*	Percentage of Total Sales Derived from Telecom Equipment
Transmission Products (cont'd)			
Farinon Canada Limited (I)	microwave radio systems for short-haul light- and medium-routes, microwave subscriber radio, some multiplex equipment	C	92
Raytheon Canada Limited	high capacity long-haul microwave radio equipment, earth stations	B	41
Spar Aerospace Products Limited	transponders and antennas for satellites, earth stations, microwave radio relay systems (primarily exported)	C	22
Transcom Electronics Manufacturing Limited	voice frequency equipment, distributes carrier and concentrator equipment	B	n.a.
Vidar (A Division of TRW)	digital transmission and switching equipment	B	100
Wescom Canada Limited (I)	primarily distributors - voice frequency equipment, PBX's, transmission equipment	B	100
Comtest Communication Products Limited	distributes test equipment, voice frequency amplifiers, and loop treatment equipment for their U.S. principal Lear Siegler, Inc.	B	100
Teleradio Systems Ltd.	distributor for - Wilcom (specialized test instruments), Anaconda of California (subscriber-carrier systems and small electronic concentrators), Caldion of New York (thin route microwave equipment)	n.a. (42 employees)	n.a.
Glenayre Electronics Ltd.	control head for mobile radio	B	33

CHART 1 (continued)

Firm	Principal Telecommunication Products Sold in Canada	Telecom. Equipment Sales Size Group*	Percentage of Total Sales Derived from Telecom Equipment
Wire and Cable			
Phillips Cables Limited	wire and cable (including optical fibre cable)	D	40
Canada Wire and Cable Limited	wire and cable (including optical fibre cable)	D	10
Pirelli Cables Limited	wire and cable	B	3
Power Suppliers			
Staticon Limited	power plant systems (rectifiers, converters, inverters and related equipment)	A	12
NIFE-Powertronic Corporation	power plant systems, battery assembly and distribution	A	13
Research Industries Ltd.	power plant systems	B	100 (approx.)
Lorain Products Canada Limited	power equipment, transmission equipment	B	100
Terminal Equipment			
Leigh Instruments Limited (I)	teleprinters	B	28
Rolm Corporation of Canada Limited	PBX's, electronic telephone sets	A	n.a. (figure for U.S. parent is 60)
Trans-Lux Corporation (I)	stock ticker terminals (produce and sell teleprinters in U.S.)	n.a.	n.a.
Gandalf Data Communications Ltd. (I)	modems (for short- and long-haul), private automatic computer exchanges (PACX's)	B	100

CHART 1 (continued)

Firm	Principal Telecommunication Products Sold in Canada	Telecom. Equipment Sales Size Group*	Percentage of Total Sales Derived from Telecom Equipment
Terminal Equipment (cont'd.)			
ESE, Limited (I)	traffic data analyzer equipment, high speed modems, equipment for remote access and test of telephone circuits	B	100 (approx.)
Mitel Corporation (I)	PBX's, tone signalling equipment (tone-to-pulse converters, tone receivers and tone generators)	B	85
AEI Telecommunications (Canada) Limited (I)	distributor for Nippon PBX's and central office switches, assembles manual switchboards for telephone answering firms, ANIPAC (automatic number identification system for long distance calls in step-by-step central offices)	C	100 (approx.)
Canadian Motorola Electronics Company (I)	mobile telephone equipment, pagers	D	82
International Systcoms Limited (I)	mobile telephone equipment, two-way dispatch radios, rural point-to-point radio telephones	B	100
Primal Communications Limited	distributor for General Electric Company of the U.K. - key pulse adapters and PBX's	n.a. (5 employees)	n.a.
Plantronics Canada Limited (I)	data products (i.e. controllers for data terminals), interactive Vu-Set Data Terminals, telex switching systems	B	n.a.
Technex International Ltd. (I)	telephone sets, loudspeaking telephones, intercoms	A	5
Develcon Electronics Ltd. (I)	limited distance data sets	A	54
RCA Limited (I)	microwave relay equipment	A	small fraction

CHART 1 (continued)

Firm	Principal Telecommunication Products Sold in Canada	Telecom. Equipment Sales Size Group*	Percentage of Total Sales Derived from Telecom Equipment
Other			
Reliable Communications and Power Products	central office connectors and protectors, station protectors, terminating blocks	B	100
Superior Continental Canada Ltd.	load coils, carrier equipment, outdoor cross-connect housings	B	100
Bartronics 1972 Limited	converter to dial pulse for radio telephones	A	100
Bertus Industrial Limited	HF patching equipment, test lamps, message register cabinets telex equipment service and maintenance	A	100
Cook Electric Company of Canada Limited	protective equipment for central offices and for subscriber equipment, signalling products	B	100
Intertel Limited	alarm and supervisory control systems for radio relay and central office equipment	n.a. (25 employees)	n.a.
Quality Communications Products Limited	loading coils, capacitors, key telephone unit line cards	B	100
SED Systems Ltd.	pulse automatic dialers, pulse dialer programmers	A	12
TeleMaster Electronics (I)	apartment intercom	n.a. (4 employees)	n.a.

4. Switches

The design of switches and telecommunication systems takes into account the fact that subscribers are in contact intermittently and for brief periods (in spite of the perception of parents of teenagers). In practice, the level of service provided by a telco will require subscribers occasionally to re-dial during peak traffic periods because one of the switches through which their calls are passing is operating at capacity.

In the hierarchy of switches developed for the North American telephone system by AT&T, those to which subscribers are directly connected are referred to as "Class 5" switches. The remaining levels of switches are used in long distance traffic. In some cases switches are required to serve both Class 4 (long distance) and Class 5 functions. Class 3 to Class 1 switches cover progressively larger geographical areas. In Canada there are also three international gateway switches (Montreal, Toronto and Vancouver) through which international traffic, other than to the United States, is routed. The greatest part of switching capacity by far consists of Class 5 and Class 4 offices.

a) Transmission and Switching

Transmission is the operation of sending messages over distance, generally over cable or radio waves. The amount of cable or the number of radio channels required for the traffic flow is economized in two ways. The first is through the use of tandem switches to direct traffic between switching points. Tandem switches are primarily found in large metropolitan areas, where there are many local switches. The second way of economizing on transmission capacity is through techniques, called "multiplexing", which allow a number of messages to be sent over the same transmission medium at the same time. One technique in use, "frequency division multiplexing", is based on a partitioning of the frequencies of electrical waves so that several waves of different frequencies can be transmitted at the same time. A second technique, "time division multiplexing", is dependent on the digitizing of a sample of signals, and, in a sense, on squeezing the signals closer together so that the amount of traffic transmitted per unit of time is a large multiple of what could be sent when a transmission medium is reserved for the traffic between two subscribers. The most recent vintage of switching technology, in which Northern is one of the leaders, incorporates time division multiplexing into the switching operation. This fact is reflected in the name that Northern has selected for its family of switches: Digital Multiplex System (DMS). The development of this generation of switches reflects the culmination of about 20 years of evolution of technology, during which electromechanical means of control and switching were replaced by solid-state electronics employed in digital computers. The first step in the evolution was the replacement of the hard-wired common control of switches by software-controlled electronic systems. This was followed by the digitization of signals and the use of electronic technology in the actual switching operation.

b) Vintages of Switches in Place

The rate at which orders for digital switches will flow to suppliers depends in large measure on the vintages of the existing systems of their customers; the older the systems, the larger the orders within the near future. Systems which adopted state-of-the-art equipment in the last 15 to 20 years offer smaller markets than those which held off for one reason or another, such as in anticipation of the arrival of fully electronic switching systems. For instance, because the French system was antiquated, it has provided in recent years a very large market for digital switching and other telecommunication equipment. Bell Canada, as shown in Table 6, and AT&T are at the other extreme in terms of the rate at which digital switches will penetrate their market. GTE expects that 75 per cent of the switching of its operating companies, who stayed with step-by-step in anticipation of electronic switching, will be digital by 1985, which indicates very large sales for Automatic Electric. Other telephone companies in the U.S. also plan for the rapid introduction of digital switching into their networks: 80 per cent in the case of Continental Tel., and 67 per cent in that of United Telecom by 1990; and 90 per cent for Central Tel., by 1987. However, while 90 per cent of the AT&T system's switching is predicted to be stored-program control, the greatest part of it - 70 per cent - will be analogue, space-division in 1990. This, of course, reflects AT&T's heavy investment in the preceding generation of switches.

Table 6 shows the percentage distribution of telephones connected to the principal types of switching equipment in central offices. In addition to the operating areas of Bell Canada and B.C. Tel, Alberta is shown because it provides an example of the effect of rapid growth on the introduction of new technology. The column showing the percentage of lines connected to "electronic" switches primarily includes stored-program control switches; the Northern SP-1, the larger switch on which it is based, Western Electric's No. 1-ESS, and GTE's C-1 EAX and Nos. 1 and 2 EAX, as well as the truly digital switches introduced by Northern in 1977. Outside of Quebec and Ontario, Alberta was the first to use stored-program control switches beginning in 1972. Until 1980, the digital switches purchased by Canadian telcos were almost all Northern's DMS family of switches. By 1981, five Canadian telcos, including B.C. Tel, had purchased GTE's No. 5 EAX.

Because B.C. Tel did not adopt the crossbar generation of switches, it is moving to stored-program control and digital switches at a faster rate than other telcos, with the exception of those in Alberta. The number of telephones in Alberta grew by 68 per cent between 1974 and 1980, compared to 37 per cent in British Columbia and 28 per cent in Ontario-Quebec. Some of the growth in switching capacity takes the form of the most advanced equipment, and the remainder results in increases in the capacity of existing switches. In Canada, the

TABLE 6

PERCENTAGE OF TELEPHONES CONNECTED TO CENTRAL OFFICES BY TYPE OF SWITCHING EQUIPMENT*
1974, 1977, 1980

	YEAR	STEP-BY-STEP	CROSSBAR	ELECTRONIC
QUEBEC-ONTARIO	1974	55.6	38.4	6.0
	1977	46.7	39.6	13.6
	1980	41.1	40.2	18.7
ALBERTA	1974	70.8	22.7	6.6
	1977	50.2	21.1	28.7
	1980	34.4	21.9	43.8
BRITISH COLUMBIA	1974	97.3	0.3	2.5
	1977	88.4	**	11.6
	1980	69.6	**	30.4
CANADA	1974	62.6	32.3	5.0
	1977	53.0	33.5	13.5
	1980	45.1	33.6	21.3

SOURCE: Statistics Canada, *Telephone Statistics*, Table 10, 1974, 1977 and 1980.

* "Other" types of switches, to which 1.1 per cent and 0.6 per cent of telephones were connected in Canada in 1977 and 1980, respectively, have been excluded in calculating the percentage distribution in the table.

** Less than one half of one per cent.

number of telephones connected to step-by-step switching equipment continued to increase until 1975. As regards crossbar switches, there was still strong growth until 1980, the last year for which data are available on the number of telephones in Canada connected to this generation of equipment. This fact is reflected in Table 6, which shows that the percentage of telephones connected to crossbar switches rose moderately between 1974 and 1980, a period during which there was an increase of more than four million telephones. The considerable growth in the number of telephones connected to crossbar switches in Alberta is reflected in the marginal changes in their share.

While the number of telephones connected to crossbar and stored-program analogue switches will probably continue to increase for several more years, the annual demand for these systems should decrease. Between 1971 and 1975 the annual additions in Canada of the number of telephones connected to crossbar switches averaged 350,000 lines, compared to 239,000 lines between 1976 and 1980. The demand is primarily for switching capacity, rather than for additional units of common-control equipment. Once again, the same should hold for stored-program control analogue switches. The race to sell these earlier generations of equipment is already run; a telco's orders almost invariably go to those companies that supplied the equipment in use.

According to a report in the *Electronic News* of October 27, 1980, Bell Canada expected "all of its toll switching operations and 40 per cent of its local switching facilities [to] be digital" by the year 2000. Given that digital switches will be installed in new central offices, Table 6 suggests that most, but not all, of the step-by-step switches will be replaced by that date. Based on the high percentage of step-by-step equipment in British Columbia, the move to digital switching there should occur more rapidly than in Bell territory, particularly if British Columbia growth rates continue to exceed those in Central Canada. On average, the changeover should also proceed somewhat more quickly in the

Atlantic Provinces, Manitoba and Saskatchewan, where 49.5 per cent of the telephones are connected to step-by-step equipment,* than in Bell's territory.

c) Switching Development

Much of the information on digital switching is very recent. It is available primarily from the trade and business press. Where the information is not controversial in terms of this inquiry, it has been used without attribution.

The firms with the potential to be key international suppliers are: Western Electric, LM Ericsson Limited, Northern Telecom Limited, International Telephone & Telegraph, Siemens, AG, Nippon Electric Company, CIT-Alcatel, General Telephone & Electronics, Philips Electronics Ltd., Thomson-CSF, Fujitsu, and the developers of "System X" in Britain - Plessey, General Electric Company, and Standard Telephones and Cables, an ITT subsidiary. Two of the early leaders were LM Ericsson and Northern Telecom. LM Ericsson was reported in 1979 to have installed switches serving two million lines in 20 countries. In addition to being early off the mark, LM Ericsson has had plants for a number of years in many parts of the world and has had a sound reputation in switching technology. Northern, without world-wide manufacturing facilities, concentrated its expansion efforts in the United States and became the leading supplier of local digital switches in a highly competitive environment.

Local digital switches were first supplied in the United States in 1976 and 1977, with the early efforts of suppliers directed to the independent telephone companies. Because of the needs of these companies and the state of development of technology, the switches offered were for small central offices. Although Western Electric had already introduced a digital switch, the No. 4 ESS for long distance traffic, it was not until late 1981, after three-and-one-half years of development effort, that it introduced a local switch - the No. 5 ESS. GTE also first introduced a digital toll switch, No. 3 EAX, and only brought out its No. 5 EAX, a modular local system in 1981. The AT&T operating companies were purchasing Western Electric's stored-program analogue switches and, to some extent, digital switches from Northern Telecom and ITT. In late 1979, Northern won approval from AT&T for its DMS-10, a local switch with a capacity of 6,000 lines. Northern also obtained large orders in that year from Continental Tel. and Central Tel., two of the largest independent telcos. In 1980 an AT&T operating telco, New York Tel., agreed to purchase a DMS-100 and an ITT North switch of similar size that had been sold in generally smaller configurations to the independent telcos. The line capacity of the DMS-100 is 100,000 lines, however, this has not been approached in any existing installations. The initial capacities of the New York installations will be about 29,000 lines.

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* It is possible that overall system optimization could result in newer vintage equipment being replaced more quickly than step-by-step equipment in some cases.

The early entrants in the United States, in addition to Northern and ITT North, were Stromberg-Carlson, then a subsidiary of General Dynamics; Vidar (A Division of TRW Inc.); and Nippon Electric Company. Stromberg-Carlson and Vidar were the smallest firms to produce central office switches.

Vidar had produced digital multiplex equipment and subscriber carrier systems that incorporated pulse code modulation, but it was not a supplier of PBXs. Subscriber carrier systems are multiplexers used where there is a small concentration of population some distance from a central office. The traffic to and from subscribers is sent over a small number of lines, thus avoiding the use of long local loops for each subscriber. For some applications, subscriber carrier systems and small local switches might be considered to be competing pieces of equipment. Small digital central offices are probably within the technological reach of suppliers of digital PBXs, but there have been few such entrants, which is probably due more to marketing considerations than to know-how entry barriers. Harris Digital Telephones System is one example of such an entrant. This firm recently introduced a small rural electronic exchange with a maximum line size of 800 lines that is reported to be an adaptation of a PBX. The maximum size of the Vidar switches is 12,000 lines, and the average installed capacity is less than 2,000 lines.

It was also reported that Lynch Communication Systems Inc. had been doing development work on a central office switch which it abandoned after CIT-Alcatel acquired a 25 per cent equity interest in Lynch and entered into a joint marketing agreement with it. Lynch's technological experience, based on its product line, was closest to that of Vidar before Vidar developed a central office digital switch. Lynch had entered into a joint effort with Cook Engineering, Canandaigua, New York, to develop a switch. A joint development effort for central office switching involving a firm that was not a telecommunication equipment supplier was the arrangement that Italtel, the government-owned principal supplier in the Italian market, entered into with Advanced Business Communications, Dallas, Texas, which is described as an R&D firm. This effort resulted in a small (less than 10,000 lines), combined Class 4 and Class 5 digital switch. Italtel has since reportedly entered into an agreement with GTE for joint development of a larger digital switch. It may be presumed that GTE's arrangement with Italtel is for a switch based on the transmission standard of 30 channels, adopted in Europe. The existing GTE digital switch is based on the 24-channel, North American standard.

Towards the end of 1981, Vidar announced that it was withdrawing as a supplier of digital central office switches. Vidar has been the first casualty resulting from high development costs and tough competition among a growing number of suppliers. An effect of the withdrawal of Vidar is that the planned entry of Fujitsu digital central office switches has been aborted. Fujitsu had announced, in November 1980, this entry through its subsidiary, American Telecom, which was assembling and marketing its PBX digital switches. According to a report in the *Electronic News* of February 1, 1982, the Vidar withdrawal resulted in the cancellation orders for Fujitsu digital central office switches, which led to the decision on the part of Fujitsu not to proceed with its plans for entry.

Other reports of troubled times for digital switching suppliers are reflected in losses on the telecommunication business of General Dynamics in 1981.* In 1982 General Dynamics sold Stromberg-Carlson to United Technologies, which in turn sold the central office switching business of Stromberg-Carlson to Plessey Canada Limited. United Technologies is reported to be primarily interested in the subscriber apparatus field, part of Stromberg-Carlson's operations. To date Northern Telecom is the only supplier selling to the independent telco market in the U.S. to report that its digital central office switching business is profitable.

There is a considerable difference in the scale of development effort required to produce large central office and toll switches as compared to that needed for smaller switches marketed to the independent telephone companies. On the other hand, there is a great difference in the size of the market available to firms able to address the full range of switching needs compared to that available to the more specialized firms.

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* Despite its experience with Vidar, Continental Tel., Vidar's biggest customer, placed a very large order with Stromberg-Carlson in early 1982. It might be noted that Continental Tel. purchased more digital central office equipment from Northern than from Vidar.

Development costs of digital switches can run very high for large local and toll offices. The development cost of System X has been cited as 200 million pounds in *The Economist* of April 13, 1982. The costs to Northern of developing its range of DMS switches had been $160 million towards the end of 1981, with expenditures until the end of 1985 expected to total an additional $350 million. While Western Electric has not released figures on its development, it took three-and-one-half years to develop its Class 5 switch, even though it had already developed a Class 4 toll switch. The chairman and chief executive officer of GTE was quoted as stating that GTE was spending $90 million on communication R&D in 1979. A very large part of these expenses were undoubtedly for digital switching systems.*

As is clear from the pattern of development expenditures on digital switching by Northern - a pattern similar to that of the previous generation of central office switches, the SP-1 - the expenditures do not occur in one large lump at the beginning of the product's life. Rather, initial expenditures required to bring the product to the market are a small part of ultimate total expenditures on its development. The reason for this is that the product continues to be improved, in large part by the addition of new software, and its costs reduced until it is superseded by the next generation of equipment. Thus, how far product development proceeds depends on past and expected sales. The two are closely related, partly because future sales are directly tied to expansion of the installed base, but also because a product that has been well received is likely to enjoy continued success. Thus, Northern's projections of continuing large development expenditures are a reflection of its past success.

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* As a rough comparison, Northern's total expenditure on R&D, excluding Bell-supported projects conducted by BNR, were $132.6 million in 1979. However, in excess of $14 million was devoted to electronic office systems, which was the amount spent in 1978 by Data 100 and Sycor, which were acquired by Northern in that year.

Towards the end of 1981, Northern had an installed base of one million lines of digital switching in the United States, with another one-and-one-half million lines on order. It was reported to have "booked orders" totalling five million lines, which suggests that sales and orders in Canada and the rest of the world combined were of the same magnitude as those obtained in the United States. Of the firms active in the United States, ITT had shipped 500,000 lines and had an additional 175,000 lines on order. Sales outside the U.S. would add to this total. For example, Mexico had selected ITT, which has switching manufacturing facilities in that country, as the principal supplier of its digital switching needs during 1982-86. ITT equipment was also being considered by Argentina, where ITT has manufacturing facilities. In addition, its U.K. subsidiary was a participant in the development of System X. ITT has recently sold a controlling interest in its subsidiary, which will not market System X, but will be the exclusive supplier of an older generation of switches to British Telecom. GTE had a very small installed base at the end of 1981, but it had 900,000 lines on order and was planning on establishing capacity after 1982 to manufacture up to 1.6 million lines per year. At the time, Stromberg-Carlson's installed base was reported to be 435,000 lines, and that of Vidar, 220,000 lines. When Vidar announced its withdrawal from digital switching, it had an installed base of 300,000 lines; Stromberg-Carlson had about 500,000 lines in the spring of 1982. Nippon Electric Company (NEC) America had an installed base and orders totalling 400,000 lines.

Although Northern had sold a number of smaller systems to AT&T operating companies, there were few reported sales to GTE operating companies by Northern or other suppliers. Thus, most of the sales and orders reported above were to the non-integrated telcos in the U.S. By world standards, these telcos provide a rather small market - about the size of that in Canada. In contrast to the level of sales of firms whose sales were concentrated in the U.S. by late 1979, LM Ericsson was reported to have installed two million lines of digital equipment in 20 countries. Approximately a year later, Thomson-CSF had order backlogs exceeding two million lines in 16 countries, while those of CIT-Alcatel were five million in 21 countries.

A manufacturing presence is required to gain access to most countries. In some countries the key is favourable credit terms. Even as strong a company as Western Electric, which will undoubtedly grow very quickly as a supplier of digital switching equipment in the U.S. now that it has developed a Class 5 digital switch,* will experience considerable difficulty in making international sales, unless it acquires widely distributed manufacturing facilities.**

For example, AT&T International was successful in December 1979 in winning a contract from the Republic of Korea to develop its telephone system and to transfer technology. Approximately a year later, Western Electric acquired a 44 per cent interest in a Korean company that had been selected by the government to act as the vehicle for the development of know-how and manufacturing facilities.

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* Not all new contracts are for state-of-the-art (i.e., digital) switches. Sales of stored-program analogue switches for new installations are still occurring. However, given the heavy push to digital switching systems by all major suppliers, they are an essential element in any firm's competitive position.

** There are trade press reports of talks between AT&T and Philips Lamp Holding Company of The Netherlands, which has a wide marketing network, regarding joint ventures in telecommunications.

In central office switching, as in other areas where Northern is a leader in technology, its success outside of North America has primarily taken the form of the licensing of its technology. According to an announcement in August 1981, Northern's technology for its DMS-100 and DMS-200 will be used by two Austrian suppliers, while Siemens' designs will be used by the Austrian subsidiaries of ITT and Siemens. Northern also has a technology transfer agreement with Sweden for the SL-1, its large PBX digital switch, and with the German Bundespost for the SL-10, its data switch.

d) Special and Private Carrier Switching Requirements

The liberalization of terminal and system interconnection in the United States, as well as the application of new technology, have resulted in the development of markets for switches outside of the traditional voice communication telco market.

The fact that telco subscribers may own terminal equipment appears to have increased the interest of large firms in creating their own networks. These firms, like the public carriers, find it efficient to replace transmission mediums with tandem switches that direct traffic among PBXs. These tandem switches are also used by special carriers such as MCI Communications Corp., or Southern Pacific on their specialized networks. As well, large PBXs are adapted for the use of specialized carriers. One of the principal suppliers of this equipment is Danray, Inc., which was acquired by Northern in 1977. Recently Northern Telecom Inc. added a high-capacity digital multiplex switch, the DMS-250, to the product offerings in the specialized carrier market. With a capacity of 30,000 trunks, it far outstrips Danray's largest existing switch, the CTSS-4000, which can handle up to 4,000 trunks. Northern won a large order - 20 switches, worth $30 million - from Satellite Business Systems (SBS), with first deliveries scheduled for early 1982.

The DMS-250 will provide interconnection between the SBS exchange services earth stations and telephone company access lines. According to a report in the *Electronic News*, the DMS-250 will be available with full end-office capabilities in 1983. The size of the Canadian market and the fact that the current regulatory environment does not encourage the setting up of specialized carriers means that demand in Canada for switches used by such carriers and in private systems will be incremental to the U.S. market.

Another specialized switching area exists in the data field. Data systems such as CNCP's Infoswitch and TCTS's Datapac require their own switches as long as the telecommunication system of the telcos is predominantly analogue. In a fully digital system the distinction between voice and data (as well as facsimile, etc.) will disappear and it should be possible to utilize a single system for all types of traffic. As is clear from the projections for Bell Canada and AT&T, the time when the voice network in North America is fully digital lies far in the future. In the meantime, there will be continued development of specialized systems which will not simply fade away when the voice network is completely digital.

Although classified by Northern with its subscriber switching equipment, the SL-10 packet switching system is used by telcos, TCTS members (Datapac) and the German Bundespost. It could, however, be used in private data systems and, of course, in specialized networks not associated with telcos.

A rapidly developing area of technology that requires switching capacity is the cellular radio system.

In high-density areas, available channel capacity severely limits the number of mobile telephone subscribers who can be accommodated. Cellular radio design is based on re-using radio frequencies within a metropolitan area. This is accomplished by using weak radio signals, so that signals transmitted to users in one cell do not interfere with signals transmitted on the same frequency in another cell. Interference is also avoided by separating cells on the same channels by a number of cells in which other frequencies are used.

Cellular radio is in the process of being introduced in the United States and in several parts of Canada. In experimental operations in Chicago, AT&T adapted its No. 1-ESS computer for use in the system. Motorola, the major supplier of mobile telephones and pagers, is developing its own computerized switching system, which it has been using in small-scale experiments in Washington and Baltimore. Another supplier that more recently entered the market is the Anaconda-Ericsson joint venture. It will be offering an adapted LM Ericsson digital central office switch in its system, which LM Ericsson has already sold in the Scandinavian countries and to Spain and Saudi Arabia. In projections, AT&T planned to develop systems in 70 cities.

Northern recently announced its entry into this market through a joint venture with General Electric Co., Fairfield, Connecticut. The switching equipment for the system under development is based on Northern's DMS-100. Northern's development work will take place in Richardson, Texas, and at BNR in Ottawa. Introduction of the system is planned for early 1984.

5. Transmission

Transmission is the carrying of information between locations. A transmission system uses wire pairs, coaxial cables, terrestrial and satellite microwave radio, and, recently, optical fibres. There are a large number of individual pieces of equipment that are used to carry the information, to maintain its quality, and to improve the economics of sending it over distance.

According to Northern, "Within the industry, transmission equipment generally refers to the electronic products used" in carrying information over any system. There are three broad product areas - multiplex, radio, and voice frequency products.

As in the case of switching, transmission technology is rapidly changing. Mr. E.V. Hird, President and Chief Executive Officer, GTE Lenkurt Electric (Canada) Ltd., stressed that, compared to switching, the research and development costs of transmission equipment are low.

> "I should put this in perspective and I meant to get this in the record. The research and development dollars for transmission are much smaller than the switching. The development time is much less and you are, say, two years for a product and $2 million is a large sum for development of a transmission product versus $100 million for switching."

R&D expenditures are, nevertheless, important in this area. Most firms who gave an indication of their R&D expenditures reported amounts approximating at least 6 per cent of sales. Without such expenditures, a product line can quickly become obsolete. This can be seen by looking at the transmission products now being marketed, almost all of which were introduced within the last decade. The period of time during which these products can be sold, without at least significant technological improvements to extend their marketable life, is also declining.

The principal manufacturing activities in the production of transmission equipment were summarized by Mr. C.G. Millar, Executive Vice-President, Operations, Northern Telecom Limited. These are

> "coil winding, circuit pack manufacturing and testing, equipment shelf and bay assembly, wiring and testing for multiplex and voice frequency products and the assembly and testing of microwave radio equipment."

Mr. Millar stated that common production processes in the manufacture of transmission products has led Northern to utilize multi-product plants, where a variety of products are produced in relatively small quantities. Northern has two such plants in Quebec and a satellite digital transmission plant in Winnipeg. The quantities that Northern achieves do not permit much use of production facilities dedicated to single equipment items. Lenkurt opened dedicated facilities in Winnipeg (microwave radio) and Saskatoon (digital multiplex), which added to their existing Burnaby, B.C., facility. Mr. E.V. Hird, of Lenkurt, said that the Saskatoon facility would have to triple its output in order to realize the available scale economies. He stated that the U.S. plant in Albuquerque, New Mexico, had five times the level of output of the Saskatoon facility, and 15-20 per cent lower costs.

Although some capital substitution has taken place with the recent generations of sophisticated transmission equipment, most manufacturing operations remain highly labour intensive. Capital-intensive operations, such as automated testing, generally are justified only when the production volume increases. Costs fall as production-runs lengthen, due to the increased specialization of labour and equipment.

Northern Telecom manufactures some components and printed circuit boards for use in their products. All of the companies purchase some electronic components produced in the U.S. or in Asian countries. Volume discounts are obtainable in purchasing components, which are a large share of total costs. Lenkurt (Canada) (now part of AEL Microtel Limited) co-operates with Lenkurt in the U.S. on component purchases.

a) Multiplex Equipment

Multiplexing involves techniques for concentrating telecommunication signals in order to take advantage of the physical capacity of transmission mediums.

The older method, frequency division multiplexing, was analogue. Digital techniques, based on pulse code modulation, were introduced by AT&T in the early 1960s, and were developed rapidly during the 1970s. As noted earlier, digital techniques have also been incorporated into switching technology, so that the distinction between multiplexing and switching is disappearing.

The frequency band which is adequate to transmit voice traffic is 300-3,400 hertz (the number of cycles per second). Any one of the mediums used for carrying messages is physically capable of accommodating a bandwidth many times that used for a single voice conversation. In frequency division multiplex the bandwidth is divided into separate channels, each of which is used for a separate voice conversation. Here, as in so many areas of telecommunications, AT&T was a leader in the development of the technology.

Most of the evidence in this inquiry, with respect to multiplex equipment, has related to digital multiplex. Multiplexing of voice traffic is achieved with digital techniques by first sampling the analogue electrical waves and then converting the samples to a numerical code, which in turn is translated to a binary code.* A number of channels (usually 24) are sequentially sampled, the samples are coded and transmitted in sequential pulses. The pulses may be transmitted by the use of wire pairs or they may be used to modulate a radio transmitter (microwave). At the receiving end of the radio system, the signal is demodulated and the pulses are recovered; these pulses as they are received on a wire pair are decoded and the original analogue electrical signal is reconstituted.

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* Samples are taken at the rate of 8,000/sec., which is sufficient to assure that no information from a signal covering a bandwidth of four kilohertz is lost.

In most countries outside of North America, the standard for digital multiplex systems is the 30-voice channel, and digital switches also follow this standard. In North America, the standard is the 24-voice channel. Switches designed to the one standard must be redesigned for use in an area where the other standard has been adopted. Although different signaling standards in North America and in Europe have always necessitated some equipment redesign, the redesign required in the case of digital multiplex equipment appears to be more fundamental than that required for previous generations of equipment.*

In both frequency division and digital multiplexing there is a hierarchy of groups of voice channels which permits a larger number of channels to be sent over wideband, long distance transmission links. In frequency division multiplexing, the voice channels are built up in groups of 3, 12, 60, 600 and 3,600 voice channels. The groups in digital multiplex consist of 24, 96, 672 and 4,032 voice channels. The 24-channel system is used over wire pairs and cable in Canada, and it provides much of the transmission capacity between switches where there is extended area service and short-haul toll traffic. Until the recent installation of a digital microwave system in Canada, only frequency division multiplex was used in microwave radio systems.

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* In this connection, it is noteworthy that ITT has reportedly asked AT&T for aid in converting its large digital multiplex switch, designed to the 30-voice-channel standard, to meet the North American 24-voice-channel standard. This request was part of the settlement of the suit which ITT had brought against AT&T in an effort to gain access to the AT&T telecommunication equipment markets.

Multiplex equipment is located at central offices. There are banks of shelves which contain the plug-in units which perform the modulation, demodulation and filtering of signals for each channel. Each system has its own power supply. The central office also contains equipment for generating the carrier signals which are modulated in the multiplexing operation. The carrier signals are the guided signal equivalent to radio waves. As information is transmitted along a twisted wire pair or coaxial cable, there is a gradual attenuation of the signal and repeaters are used to boost the strength of the multiplexed signal. The power for the repeaters is usually sent from the central office.

In the case of analogue repeaters, the entire signal received is boosted. This means that, not only the original information but also noise picked up along the way is boosted in signal strength and sent along to the next repeater. Digital repeaters, however, regenerate the signal; that is, they identify and reform the signal. As long as the repeaters are spaced sufficiently close together to permit regeneration of the signal, the information arriving at its destination should be identical to that originally sent, and should be free of extraneous noise. Digital repeaters on wire pairs and coaxial cables are spaced about 1,830 metres apart.

Multiplex equipment, carrier generating equipment and repeaters are included with "other" transmission equipment in Table 1. Also included in this category are voice frequency products, which are discussed later. Expenditures on "other" transmission equipment ranged from $103.9 million in 1973 to $218.0 million in 1977, and constituted from 11 per cent to 14.6 per cent of total expenditures on equipment. As in the case of other types of equipment, installation charges, where incurred, are included in the expenditures.

Shipments of multiplex equipment were separately identified by Statistics Canada in its annual report on communications equipment manufacturers for only a few years in the 1970s. Shipments in 1974 and 1975 were

$44.0 million and $56.7 million respectively. In 1978, the only other year for which separate data are provided, shipments were $43.9 million. The rules usually followed by Statistics Canada are that, when shipments of any category of goods are made by fewer than three firms, or when one firm accounts for 75 per cent, or two firms account for 90 per cent of the shipments ("market dominance"), then the value of shipments is combined with that of another category. "Market dominance" was the reason for combining categories since there were more than three reporting firms. Shipments of carrier equipment in 1974, the last year for which separate figures for this category were provided, were $39.8 million.

Lenkurt Electric (Canada) Limited and Northern Telecom are the principal suppliers of analogue multiplex equipment. General Electric Company of England was also named as a competitor by Mr. E.V. Hird. He stated that Lenkurt had a highly advanced analogue system that "dominated" the non-Bell market. He provided the following breakdown of his perception of Lenkurt's approximate share of provincial sales.

	Per Cent
British Columbia	90
Alberta	90
Saskatchewan	90
Manitoba	80
Ontario-Quebec	(see below)
The New Brunswick Telephone Company, Limited	40
Maritime Telegraph and Telephone Company, Limited	70
Newfoundland Telephone Company Limited	20
CNT	40
The Island Telephone Company Limited	80

Lenkurt's sales to Bell were $89,000 in 1975, $38,000 in 1976, and $23,000 in 1977. It was Mr. Hird's view that Lenkurt accounted for 80 per cent of sales to hydro and railway customers in Ontario and Quebec.

In the digital multiplex market, Lenkurt carries the 91A PCM. Mr. Hird said that they competed mainly with Northern and Vidar, and, to a lesser extent, with Lynch and ITT. The Northern product with which they compete is the DE-3. The Vidar unit is called the Vidar D-3. Mr. Hird said that the competition in digital multiplex was "fiercer" than in analogue multiplex. He said that this might be due to the fact that analogue multiplex is so complex that many companies may not have felt that the investment was worthwhile. Also, the technology is widely accessible through licensing from Western Electric for the manufacture of digital multiplex.

Mr. Hird broke down the market shares for digital multiplex as follows:

		Per Cent
British Columbia	Lenkurt	90
	Vidar	10
Alberta	Market is split three ways - between Lenkurt, Northern Telecom and Vidar	
Saskatchewan	Lenkurt	90
Manitoba	Northern Telecom	90
Maritime Telegraph and Telephone Company, Limited	Lenkurt	80
The New Brunswick Telephone Company, Limited	Northern Telecom	100
Newfoundland Telephone Company Limited	Northern Telecom	80
	Lenkurt	20
The Island Telephone Company Limited	Lenkurt	90

Mr. Hird said that purchases of multiplex and microwave equipment were based primarily on price and that there was no native-son preference given.

b) Radio

In the case of radio, the signals are propagated through the air. Information is sent by means of radio waves using modulation techniques. The techniques made familiar by commercial broadcasting are amplitude modulation (AM) and frequency modulation (FM). The latter technique is mostly used in analogue radio transmission.

Because a specific physical highway is not needed to send radio waves, radio is widely used to send information. Portable radios are used in vehicles on land, sea and air for two-way communication. As well, radios and pagers are carried by individuals. One of the tasks of policymakers at the national and international levels is the allocation of the radio spectrum so that the demand is met without creating interference in transmission between users. To avoid interference, frequencies must be allocated so that different signals carried on the same frequency band are not received in the same area.

The allocation of frequencies at the international level is done at world conferences of the International Telecommunication Union. The extent to which individual countries follow recommendations flowing from these conferences at a national level varies from country to country. A comparison of the Canadian allocation tables with the recommendations of the International Telecommunication Union shows a close correspondence. Mr. D.J. Hadley of Farinon Canada Limited and Mr. Hird stated that equipment designed for Canadian applications had good export potential from the viewpoint of compatibility between Canadian and foreign equipment. This was less true of equipment developed for the U.S. market.

Spectrum allocation, as well as technical standards, are important in determining compatibility of equipment in any two countries.

Radio is used by telecommunication common carriers for mobile telephone and paging services, to a very limited extent in providing rural telephone service where the distances are too great to use wire connections, and as a long distance transmission medium. As noted earlier, most of Canada's long-haul transmission of telecommunication traffic is via microwave radio. The term microwave has a widespread and elastic usage. Some equipment, which operates below the 1 GHz bandwidth is described as microwave radio in Farinon's product brochures. Some writers place the bottom end of the microwave range at 1 GHz. Northern's handbook sets it at 2 GHz. Originating traffic is transmitted in a narrowly focussed pattern between a line-of-sight transmitter/receiver. The curvature of the earth results in an outside range between transmitters and receivers of about 30 miles. The number of repeaters through which a long distance call travels can thus be very numerous. The cost of a transmitter/receiver in 1980 was placed by Northern at around $15,000. This represented a small part of the cost of a repeater site, which includes the tower and power supplies. According to Northern, the average total cost of repeater stations was of the order of $250,000.

Between 1975 and 1977, the major telecommunication companies spent annually, on average, $60 million on radio equipment (Table 1). This figure includes the structures needed for repeater stations, as well as the engineering and other services required to install microwave radio systems. Also included in the expenditures on radio equipment of the telecommunication common carriers is the cost of purchase and installation of the base stations which are used in mobile telephone and paging systems. The level of expenditures on this equipment is not known; however, according to Northern's product handbook, the "predominant radio transmission product" is microwave radio.

Between 1975 and 1977, expenditures by the major telecommunication carriers averaged $19 million. Almost 60 per cent of these expenditures were made by carriers in the western provinces, with AGT being the major purchaser. Expenditures on mobile telephone and paging equipment by radio common carriers, and on mobile radio equipment for private systems, are unknown. As will be discussed subsequently, recent developments in mobile telephones indicate that this product category may become the most important expense item in radio.

Information for more recent years is available on shipments. Table 7 shows shipments of point-to-point and of land mobile radio equipment.

TABLE 7

SHIPMENTS OF POINT-TO-POINT AND LAND MOBILE RADIOS FOR CIVILIAN USE 1978-80*

	1978	1979	1980
		($ millions)	
Land Mobile	32.5	28.1	13.3
Point to Point	95.8	69.7	104.4

SOURCE: Statistics Canada, *Communications equipment manufacturers, 1978-80.*

* Shipments of radio equipment for defence were $35.2 million in 1978, $84.1 million in 1979 and $102.3 million in 1980. These totals include land mobile, point-to-point, aviation and marine equipment. Aviation and marine equipment for civilian use averaged $55.8 million over the three years.

c) Microwave Radio Suppliers

The evidence before the Commission on the market for radio equipment related almost exclusively to microwave radio supply and purchase.*

There are four principal suppliers of microwave equipment to Canadian telecommunication carriers. These are Northern, Raytheon Canada Limited, Lenkurt and Farinon Canada Limited, which was acquired, along with its parent, by Harris Corporation. Northern and Raytheon produce high-capacity, long-haul equipment. Farinon and Lenkurt produce equipment for short-haul and light- and medium-route applications. There are a large number of potential competitors in all areas of microwave radio, however, including a number of Japanese and U.S. firms.

In the 1975 returns of information by the telcos, these four firms and RCA were shown as suppliers of microwave equipment. The terrestrial microwave, satellite antenna and transponder (the repeater used in satellites) part of RCA's operations in Canada in 1977 were sold to Spar Aerospace Products Limited. Spar has phased out its participation in terrestrial microwave, both in Canada and in the export market. It is the sole Canadian supplier of transponders, and it also supplies ground antennas for satellite communications. Raytheon and SED Systems Inc.,** a small development-oriented supplier in Saskatoon, supply ground antennas as well.

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* Although there was a good deal of evidence with regard to mobile telephone and paging, it related primarily to questions of inter-connection between the systems operated by radio common carriers and the land line system of the telephone companies, and was presented in Part I.

** SED has recently been reorganized following disappointing financial results.

The cross-country microwave systems are in the 4 and 6 GHz bands. It is by its nature long-haul and the capacity requirements are considerable. Under the TCTS standards, a single radio channel can carry up to 1,800 voice channels. In commenting on the difference between Northern and Farinon equipment, Mr. Hadley stated that the Farinon equipment "has less spectrum efficiency, it is a lower capacity system". He also noted that the Northern equipment has sophisticated protection equipment and was a high-performance system. There appears to be a considerable difference in the engineering requirements of long-haul heavy-route microwave radio and that used in short- and light-route applications.

Farinon produces equipment in the 6 GHz band that is classified as medium capacity equipment - up to 1,200 voice channels. There are applications in which this equipment and Northern's heavy-route equipment are substitutes, but, for the most part, the producers of heavy-route and light-route equipment address different markets.

Farinon's microwave equipment sales were $6.6 million and $7.5 million in 1976 and 1977, respectively, with exports reaching 20 to 25 per cent, which is more than their general level of about 10 to 15 per cent. Somewhat under 40 per cent of Farinon's sales were to operators of private networks in the industrial and resource fields, e.g., pipeline companies. Raytheon had sales of telecommunication equipment, which consisted primarily of microwave equipment and associated engineering and installation, of $5.1 million in 1975 and $2.7 million in 1976. Lenkurt's sales of microwave equipment for those two years were $3.5 million and $5.0 million. A separate breakdown of Northern's sales of radio equipment is not available, but, based on sales by other suppliers, expenditures by the telecommunication carriers and the shipment data of Statistics Canada and the low volume of imports, Northern was the major supplier to the telecommunication carriers. As well as being the major supplier of heavy-route analogue equipment, Northern is the supplier of the main route digital system (DRS-8) which is being installed by the TCTS members.

Demand from any customer for microwave equipment tends to be very uneven. There is a peak of demand when a system is being installed, which is followed by a sharp fall-off which may continue for some time, until a major addition to capacity is required. The demand for heavy-route equipment appears to be particularly uneven. There are a larger number of customers for light-route systems whose demands are unrelated. This smooths the sales of suppliers of light-route systems. Mr. Hadley said that a small company, such as Farinon Canada Limited, could operate successfully, but that reasonably stable sales were required. Farinon's product brochure shows a wide range of radio products, which cover several different frequency bands and include a number of specialized applications. This product diversity may also contribute to the stabilization of sales and may explain the fairly high percentage of sales revenue (five to ten per cent) spent in product development.

In addition to supplying light-route microwave systems, Farinon had developed a subscriber radio system for lightly populated areas where wire line connections are very expensive. This system had been developed with Sask Tel and Bell. Farinon SR Systems (for subscriber radios) was sold to employees and other interests in January 1981. The new company, S R Telecom, exports 80 per cent of its output. Harris Corporation, which had been Farinon's international marketing arm, is still used for this purpose by S R Telecom.

Harris Corporation is one of the early entrants into cellular radio systems in the U.S. It has also recently established a division to develop and market private systems for all of the available transmission mediums.

The transmission division of AEL Microtel is likely to be affected by an agreement that GTE Lenkurt Inc. has reportedly entered into with Rockwell International "for the purchase of low- and high-capacity digital and analog microwave radios." Lenkurt Inc. will be closing its transmission facility and distributing its capacity to two other plants. The agreement could broaden the line of equipment available for AEL to market in Canada.

AEL recently announced an order for a 2,000-km voice/data system for the Pakistani government railway board. The order, worth in excess of $10 million, includes radio, multiplex and supervisory equipment.

Other suppliers of radio equipment include Canadian Marconi Company and the Collins Canada Division of Rockwell International of Canada Ltd., a subsidiary of Rockwell International Corporation. Neither was represented during the inquiry, but both corporate entities are described in the Department of Communications' report, *The supply of communications equipment in Canada* (1981). Canadian Marconi is 51 per cent owned by General Electric Company of the U.K. It had sales of electronic products and services equal to $81 million in 1978-79. Its telecommunication division manufactures "commercial and military land-based microwave systems and test equipment." It also supplies a broad range of other radio equipment in the VHF and UHF bands. In reviewing the competitors of Farinon, Mr. Hadley stated that Farinon competed with Marconi in the 2 and 8 GHz light-route digital field. As in the case of Marconi, Collins supplies a number of radio products in addition to microwave radio equipment, sold to Canadian hydro and transport utilities.

There are a large number of potential competitors in all areas of microwave radio. As long as the size of the market is sufficient to justify the cost of development, there do not appear to be any significant non-institutional entry barriers.

Radio transmission development is transforming telecommunications. Satellites have had a great impact on long-haul transmission, and radio is becoming a substitute for, and a complement of the local distribution and switching systems of the telcos. It is noted in the section on switching, that cellular radio, by greatly expanding the number of subscribers that can be served by mobile telephone, could, in some instances, replace the local telco system.

The importance of this area of telecommunications, both to subscribers and suppliers, prompted the Commission to try to obtain information on its state of development in Canada. Letters were sent on November 1, 1982 to B.C. Tel, AGT and Bell, the three telcos that were reported to be interested in establishing such systems, in an effort to learn who were the principal suppliers to these companies.*

The cellular systems in the U.S. are being designed for frequencies within the 800 MHz band which are being allocated by the FCC for this purpose. Two systems are to be allocated to each geographic area, one to the operating telco and the second to the radio common carriers. A number of consortia have been formed by radio common carriers and specialized carriers for this purpose. Applications from these groups and from the telcos are now being dealt with by the FCC. There could be some delay in implementing FCC decisions because of appeals.

The policy for cellular radio in Canada was set out in a notice in the *Canada Gazette,* October 1982. As in the U.S., two licences are to be granted, one to telcos and the other to other applicants. The DOC also requires that all systems for cellular radio in the

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* A reply containing the information requested was received only from AGT in time to be used in the Report.

800 MHz band be compatible with each other and with systems in the U.S. Subscriber terminal equipment of different manufacturers will thus be compatible and subscribers will be able to "roam" outside of the territory covered by their home system.

In 1980, the latest year for which figures are available from Statistics Canada, there were 40,158 mobile telephones in Alberta, compared with 50,446 for all of Canada. The application by AGT to DOC in the late 1970s was for additional spectrum capacity in the 400 MHz band. The Aurora System in Alberta, which is being field tested in Edmonton, was developed by Westech Systems Ltd.* According to the description of the system published in February 1980 by Westech, it can be used in the 400 MHz and 800 MHz bands. The 400 MHz bandwidth allows for 40 to 120 channels and is described as a medium capacity system. The systems being developed for the U.S. markets referred to in the trade literature are 100 and 200 channels, i.e., high-capacity systems. AGT requires a system which permits coverage of a large geographical area with relatively few users in each cell, whereas the systems in the U.S. are designed for small, densely populated, areas.

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* Westech was formed in late 1978 by AGT, A E S Data Ltd. and International Systcoms. According to a newspaper report, Nova Corp., Calgary, and AGT are to develop, manufacture and market Aurora in a joint venture, with Nova acquiring certain assets from International Systcoms.

The suppliers of the Aurora System who are mentioned in the letter to the Commission from AGT are shown below:

"Control Heads

- Developed by International Systcoms Montreal, in conjunction with AGT, specifically for the Aurora Mobile Telephone.

Mobile Transceivers

- Developed by International Systcoms to the specification developed by AGT for the Aurora Automatic Mobile Telephone.

Terrestrial Transceivers

- Supplied by Canadian General Electric Toronto in response to a tender issued by AGT to all potential suppliers calling for the development of a transceiver to meet the Aurora System specificatons.

Antenna Combining Systems

- Developed by Phelps-Dodge (agent Lenbrook Industries) to meet the critical requirements of the Aurora Systems as specified by AGT.

Power Supply (AC/DC)

- Two suppliers have provided products in this area:
  - Canadian General Electric
  - Veeco Lambda, Melville, N.Y.

Antenna

- Supplied by Sinclair Laboratories Ltd., Concord, Ontario.

Central and Distributed Control Units and Software

- Westech Systems Ltd., Edmonton is the designer and supplier of the Aurora hardware and software for the Control and Interface network of the Aurora System. Major suppliers they have adapted are:
  - Hewlett Packard for the computer hardware equipment.
  - Wescom Ltd. for the interface modules developed to Westech specifications."

The system is being actively marketed in the Middle East, Malaysia and the U.S. Within Alberta, "120-200 Aurora Base Station sites will be established over the next five years. Each site will have six transceivers, one antenna, one antenna combining the System and one power supply." Start-up of the system is planned for late 1982 in Edmonton, with a total of 36,000 mobile units required over the first six years, of which the greatest number will be needed in 1987-88. It is projected that a like number will be required in the five years following.*

High capacity 800 MHz systems are planned for Calgary and Edmonton within a few years. The letter stated that AGT "will be evaluating available products from throughout the world" for this system.

Many firms are active in developing and marketing cellular radio systems in the U.S. Three such U.S. firms, Motorola, Western Electric and Harris Corp., have already developed systems. The joint venture of Northern and General Electric Co. are planning to introduce their system in about a year. This joint venture, which brings together firms with strength in switching and radio, follows the example of CIT-Alcatel and Philips. The joint venture of LM Ericsson and Anaconda has allowed for the entry of another offshore supplier of switches which are incorporated in the cellular systems. Nippon Electric, Hitachi and Panasonic are offering systems or are preparing to do so. They are reported to be incorporating their switches developed for telco use in Japan.

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* The price of a complete mobile unit for the Aurora system is unknown. The price of units to be used in systems in the U.S. are in excess of $2,000 U.S.

Some of the firms and joint ventures offering systems do not have plans to market mobile units. Some indication of strength in mobile unit development is indicated by the information on which firms are developing hand-held mobile units. These include Motorola, NEC America, Panasonic, Oki and E.F. Johnson. The latter company, which is not developing complete systems, was recently acquired by Western Union. The full potential of radio in local communications will only be felt when low-cost hand-held units are available, which is not likely to occur for a number of years. Early growth of cellular mobile telephone systems will be based on units in vehicles.

Wide-band transmission has a potential application in urban areas for transmittal of large volumes of information. General Electric Co. produces digital microwave equipment in the 23 GHz band that is marketed to end users. With this equipment, video can be transmitted one kilometre, and voice and data three kilometres. Plantronics Inc. is developing infra-red telecommunication products. The infra-red frequencies provide the means for even higher capacity transmission. DOC has not to date received any applications for the use of the extremely high frequencies such as are employed by the equipment mentioned above.

d) Voice Frequency Products

A large number of separate products are contained in this category. They include repeaters, power boosters and connecting devices for the transmission of voice and data at voice frequencies. A fuller description of the product category and evidence concerning several of these products is discussed in Chapter VII. Northern is the major supplier. Its competitors are Wescom Canada Limited, Transcom Electronics Manufacturing Limited, Lorain Products (Canada) Limited and Lear Siegler, Inc. The first three companies named are subsidiaries of U.S. firms and the latter is a U.S. firm that is represented in Canada by a distributor, Comtest Communications Products Limited. Mr. A.W.J. Wyler, the General Manager of Comtest, said that Lear Siegler had been selling directly to B.C. Tel and AGT from the U.S., and that Comtest was the exclusive distributor in other parts of Canada.

Wescom is the largest supplier after Northern. It had sales of voice frequency products in excess of $3 million, which was more than one half of its sales of telecommunication products. According to Mr. Wyler, Wescom is particularly successful in products used for data transmission, while Northern's strength was said to reside in products for voice transmission. In 1978 Mr. F.R. Lamb, General Manager, Wescom, said it was primarily a distributor for its parent, only occasionally assembling to fill an order; sales were too low to justify production in Canada.

Lorain's principal products in the voice frequency line are power boosters. It is an important supplier of central office power equipment. It carries on assembly operations at its facility in St. Thomas, Ontario.

Transcom assembles voice frequency products and digital repeaters, and distributes other digital products. The evidence related to this company is discussed in Chapter VII.

6. Power Supply Equipment

A telephone central office must have electric power in order to function. The power supply from the electric utility company is an alternating current (AC), while most telecommunication equipment requires direct current (DC). Central offices contain power plants which include rectifiers to convert AC to DC, control devices and a distribution network. Power supply equipment also includes equipment to activate ringing and tone signals. Storage batteries in modern power plants do not deliver power under normal conditions. They are used during commercial-power failures or when there are breakdowns in other power plant equipment. Telcos buy the batteries separately from the rest of the power plant, which they tend to buy as a complete unit. There is no evidence in the inquiry on the supply of batteries.

Power supply companies, generally, produce inverters and converters. An inverter transforms DC to AC. Guaranteed AC power is required for equipment which has been designed for AC operation, such as computers. A converter transforms one level of DC to another. If, for example, 48-volt batteries were in place, and an electronic switch which operated at a lower voltage was installed, a converter would be used rather than a new battery system.

The difference between rectifiers used in telecommunications and those in industry is that the latter delivers about two-and-one-half times the 48 volts generally used to power telecommunication equipment. According to Mr. A.M. Hase, President of Staticon Limited, 80 per cent of the telcos' demand for power equipment consisted of rectifiers and the remainder of inverters and converters. Mr. M.S. Ikonomidis, Product Manager, Telecommunications, NIFE-Powertronic Corporation, placed the share of rectifiers in sales to telcos at 90 per cent. The size of the switching equipment determines that of the rectifier.

- **Suppliers**

Lorain Products (Canada) Limited is located in St. Thomas, Ontario. The company's products include power supplies and transmission equipment. It is a wholly owned subsidiary of Lorain Products Corporation of Ohio, which in turn is owned by Reliance Electric Company of Cleveland, Ohio. Other Canadian telecommunication equipment suppliers that are ultimately owned by Reliance are Reliable Communication and Power Products Ltd. and Superior Continental Canada Limited.

Lorain's sales were approximately $4 million in 1977. Its principal customer, Automatic Electric, acts as its distributor in sales to B.C. Tel and other customers. Sales to Automatic in 1975 were $1.3 million. Approximately 15 per cent of Lorain's sales were either to Northern Telecom or to Bell. Lorain was described by Mr. Bessette of Transcom as being a low-price competitor in power equipment such as loop extenders, which provide additional power required for signaling on longer loops. Lorain's products were described by Mr. P.T. Wilson, Manager, Reliable Communication and Power Products Ltd., as basically of the same design as those produced by its U.S. parent.

Research Industries Limited (RIL), Richmond, B.C., a Canadian-owned company, produces power plant systems primarily for the telco market. Its sales in 1975 were $2.1 million and in 1976 $2.7 million. AGT, B.C. Tel, MTS, MT&T, and Lenkurt were RIL's major customers.

NIFE-Powertronic Corporation is a wholly owned subsidiary of NIFE Junger AB of Sweden. The parent company had world-wide sales of $100 million, consisting of power equipment, and nickel and cadmium batteries. NIFE-Powertronic was formed in 1978 when Powertronic Corporation, Scarborough, Ontario, its subsidiary Burlec Sales Limited, a distributor of electronic components, and

NIFE-Junger Limited, which assembled and distributed batteries, were amalgamated. Sales of NIFE-Powertronic in 1978 were approximately $11 million.

Powertronic Equipment Limited, the predecessor company, had sales of $4.8 million in 1977, with only 13 per cent of the total accounted for by sales to telecommunication companies. NBTel, AGT and Newfoundland Telephone accounted for approximately 85 per cent of these sales, with the remainder divided among MT&T, Sask Tel and B.C. Tel. Powertronic had been a major supplier to Northern (and thus to Bell) until 1967 or 1968. According to the evidence of representatives of Powertronic, this company's products were replaced by those of Lorain and by those developed by Northern.

Staticon Limited, Scarborough, Ontario, a Canadian-owned company, specializes in power equipment, as do the other suppliers to the telecommunication industry, save for Northern. Only about 12 per cent of Staticon's 1978 sales of $4.5 million were made to telecommunication companies, with CNCP accounting for half of those sales. Telesat Canada was another important customer. Sales were also made to the telecommunication equipment suppliers, Northern, Lenkurt and North Electric. About 45 per cent of Staticon's sales were inverters, almost exclusively for non-telecom users.

Suppliers of power systems are being affected by the incorporation of the power equipment into the switching system by suppliers of switches, such as Northern. Although the power and switching systems are not integrated in the SP-1, according to the evidence of Mr. Ikonomidis they were often sold as a single system, and small telcos tended to purchase them as such. A telco such as AGT, which had a strong engineering department, was willing and able to specify and purchase its power system separately. In the case of digital switches, the allowable tolerances for the output of the power equipment are much narrower than for earlier generations of switches and the power equipment is integrated into the switching system.

7. Wire and Cable

In guided wave transmission systems, a conductor acts as a pathway for the signal. Early telephone transmission systems were based on metal conductors. Despite rapid advances in propagated wave transmission and the recent introduction of optical fibre technology, electrical transmission systems with metal conductors remain an important part of North American networks. Local telephone messages travel through copper wires. Copper wires and coaxial cables carry some intercity messages, and much of the overseas telephone and telegraph traffic is transmitted through submarine cable.

High purity copper has been used as a transmission medium since the late 19th century. A completed telephone circuit requires two conductors, or a wire pair, and early telephone lines consisted of two bare wires supported by insulators on poles. The congestion and maintenance problems associated with these open wire lines led to an interest in underground installations and to the development of space-saving multi-pair cable such as high-density cable consisting of 3,600 pairs in a three-and-one-half inch duct.

Multi-pair cable consists of a cable core, in which individually insulated wires are bundled together, and a sheath, or outer shell, which further protects the insulated copper wires from physical damage and outside electrical interference. The individual conductors are coated with various types of insulation: solid polyethylene (commonly referred to as PIC or plastic insulation), cellular polyethylene, paper or pulp. The cable sheaths are composed of metal shieldings with bonded polyethylene jackets. The cable can be pressurized or filled with a petroleum jelly or an absorbent powder to prevent moisture damage.

- Suppliers

Approximately one billion dollars' worth of electrical wire and cable is manufactured annually in Canada. Telephone wire and cable account for approximately one fourth of this total. Building wire and power cable combined account for one third, while magnetic wire and a variety of other conductors make up the remainder.

Canada Wire and Cable Limited, Northern Telecom Limited and Phillips Cables Limited are the main suppliers of telecommunication wire and cable in Canada. Pirelli Cables Limited entered this part of the wire and cable industry in 1974. These four companies each operate a rod-rolling mill. Canada Wire and Cable, Phillips and Pirelli all have non-telecommunication wire and cable sales that exceed their sales of telecommunication wire and cable. Northern, primarily a telecommunications supplier, sold its power cable business to Phillips in 1980.

Wire and cable sales by Canada Wire and Cable, Northern, Phillips and Pirelli account for over three fourths of reported electrical wire and cable shipments in 1976. Their telephone wire and cable sales account for 100 per cent of telephone wire and cable shipments in that year. Imports of wire and cable are low, partially due to a high rate of effective tariff protection.* These four firms thus supply almost the entire Canadian telecommunication wire and cable market. Northern exports pulp cable, designed for markets where duct congestion is a constraint, to the U.S. Although Canadian producers export some PIC cable to Asia, Africa and South America, their production is primarily for domestic use.

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* The rate of effective tariff protection is much greater than the nominal tariff because a large percentage of the material inputs used in wire and cable manufacture have much lower tariffs than apply to finished wire and cable.

Northern is the largest manufacturer of telecommunication wire in Canada and accounts for over half of domestic production. About 75 per cent of Northern's output is pulp and PIC cable. The company also makes more specialized kinds of wire and cable, some of which (e.g., inside wire) are also made by other suppliers. In 1979, about 80 per cent of Northern's PIC and domestic pulp cable sales were made to Bell Canada. While the other suppliers all manufacture polyethylene insulated cables, Northern is the only producer of pulp insulated cable in Canada. Substantial economies of scale in production, and a limited available market, have been sufficient to deter other companies from producing pulp cable in this country. Northern has the two largest telecommunication wire and cable plants in Canada. Its plant in Lachine, Quebec, which has employed over 1,000, produces copper rods and pulp cable. Its plant in Kingston, Ontario, where employment is over 500, is devoted to PIC cable. Less than 10 per cent, by value, of Northern's telecommunication wire is manufactured in the other plants.

Phillips Cables accounts for another 25 per cent of telecommunication wire and cable sales. This company is the primary cable supplier for B.C. Tel. The Canadian GTE affiliates (B.C. Tel, Okanagan Telephone Company and Québec Téléphone) purchased 90 per cent of Phillips' telecommunication wire and cable output from 1971 to 1974 under a distribution arrangement between Phillips and Automatic which terminated in 1975. Phillips is controlled by British Insulated Calender's Cables Ltd. (BICC) of England, and General Cable Corporation of New York has a substantial minority interest in the company. Phillips has a rod-rolling mill in Brockville which supplies copper rod to the company's cable plants.

Canada Wire and Cable Limited, wholly owned by Noranda Mines Limited, is Canada's largest wire and cable producer. Telecommunication wire and cable comprises one tenth of the company's sales. In 1976, sales by this company accounted for approximately one tenth of total telecommunication wire and cable sales. Canada Wire and Cable has a rod-rolling facility in Montreal East, Quebec. Its largest plants do not produce telecommunication wire and cable, which is produced in four plants where there is a mixed output of telecommunication wire and cable and power cable.

Pirelli Cables Incorporated is a wholly owned subsidiary of Pirelli Canada, which in turn is owned by Dunlop Holdings of the U.K., the Italian Pirelli SPA and the Swiss-based Société Internationale Pirelli. Some telecommunication wire and cable is produced at Pirelli's large wire and cable plant in Guelph, Ontario. Another plant, in Surrey, B.C., produces telecommunication wire and cable. Pirelli began manufacturing telecommunication wire and cable in 1974. In 1978, it was manufacturing a limited range of output and had not yet penetrated the market significantly.

Cable companies have traditionally spent a small percentage of wire and cable sales revenue on research and development. Northern spent appoximately 1.6 per cent in 1978. Pirelli, Phillips, and Canada Wire and Cable reported spending under one per cent, one per cent and 1.5 per cent, respectively. The figures for these last three companies include R&D in optics research which was an important area for Canada Wire and Cable. Many of the developments in cable technology have originated abroad. Northern uses techniques pioneered by Western Electric. Phillips and Pirelli both have access to the technology of their parents. Phillips pays a fixed undisclosed fee for access to BICC's technology; Pirelli pays technical fees averaging 2.2 per cent of sales.

Northern has maintained that its wire and cable products are distinctive. The other manufacturers have taken the position that equivalent products exist. A 1978 Pirelli price list for telecommunication wire and cable shows comparative designations by type for Pirelli, Phillips, Canada Wire and Cable and Northern products.

The purchasing practices reported by some of the telphone companies support this approach. Mr. W.S. Robertson, President and Chairman of Maritime Telegraph & Telephone Company, Limited, indicated that his company allocates its wire and cable purchases between Northern and Phillips, because the products and the prices are considered to be equivalent:

> ". . . there is one case where, in a sense, there is an allocation process and that is wire and cable where the equipment is considered to be equivalent and where the price is equivalent and we have Phillips here in the province and we have Northern here in the province and we buy from both."

Mr. G.E. Graham, Vice-President, Planning, for The New Brunswick Telephone Company, Limited, stated that his company buys three to five per cent of its cable from Phillips "as a precautionary move" in case of strikes. This, too, indicates substitutable products.

Cable prices are f.o.b. at various points in Canada. Price lists for Pirelli (1978) and Northern (1980) show that each equalizes prices at the same seventeen base points across Canada, thereby offsetting any price advantages due to location. In 1980, Northern was still using its 1978 freight rate charges from f.o.b. points to final destinations, which suggests that the entire transportation component of the price was not cost-based.

Approximate market share figures, by telephone company, are available for 1975 from returns of information. They show that Northern supplied virtually all of Bell's requirements, and that Phillips had 90 per cent of the B.C. Tel market. The situation in the Maritimes was more mixed. Although Northern was the major supplier, Phillips had about one third of the MT&T market and Canada Wire and Cable had about one fifth share of the NBTel market. Phillips was operating a plant in Nova Scotia, and Canada Wire and Cable had a plant in New

Brunswick. All three suppliers were well represented in the Prairies; again, companies with plants operating in the region had sizeable market shares.

One of the more striking features of the transmission wire and cable industry is the geographic dispersal of the facilities. Each of the four major suppliers operates several plants. In 1977, the combined total was sixteen. Table 8 shows that some of these plants are very small. Each of the suppliers had plants with fewer than 50 employees. Some of the plants produce wire and cable products other than communication wire and cable. A small part of the Pirelli plant in Guelph produces telecommunication products. The Canada Wire and Cable plants all produce electric wire and cable products other than telecommunication wire. Northern has satellite cable plants which also manufacture other products.

While pulp cable production is concentrated at Lachine, the existence of many small plants which produce other types of cable is noteworthy in light of the testimony regarding the production economies of scale obtainable in this industry. Northern's PIC cable plant at Kingston uses robotized handling equipment and computer controls for its 12 insulating lines. Mr. C.G. Millar of Northern testified that larger volumes of output would permit further economies to be derived from the use of more dedicated equipment. PIC cable is available in four standard conductor sizes (19-, 22-, 24- and 26-gauge wire), with ten colour codes for its insulation material to identify individual conductors. A plant with 40 insulating lines could dedicate each line to the production of a specific colour and size. Plants with fewer lines must regularly halt production to set up the line. When production involves cables with different numbers of wire pairs, the drum twisting operation must be adjusted. This is time-consuming and results in the production of some scrap.

Small satellite plants, with few lines, spend a significant proportion of production time setting the lines. Mr. D.G. McKay, President, Pirelli Cables Limited, testified that, in filling an order of 1,000 feet

TABLE 8

TELECOMMUNICATION WIRE AND CABLE PLANTS 1977

NORTHERN TELECOM	PHILLIPS[1]	CANADA WIRE[2]	PIRELLI[3]
Amherst (20-49)[4]	Dartmouth (20-49)[5]	St. John (20-49)	
Lachine (1000-1499)	Sentinel, Alta. (100-199)	Winnipeg (100-199)	Guelph (200-499)
Kingston (500-999)	Rimouski (50-99)	Weyburn (50-99)	Surrey
Regina (20-49)[4]	Portage la Prairie (50-99)	Vancouver (50-99)	
Calgary (20-49)	Vancouver (100-199)[6]		

SOURCE: *Manufacturers of Electric Wire and Cable*, Statistics Canada, 1977.

1) The largest Phillips plant is in Brockville and it is not specialized in telecommunication wire and cable.

2) Canada Wire and Cable has several plants producing other electric wire and cable products. The four plants shown above all produce other electric wire and cable in addition to telecommunication wire and cable.

3) Testimony indicates that telecommunication equipment employment at the Guelph facility was probably in the (0-49) size category; the Surrey facility shows no employment in the 1977 census, although 35 persons were employed there by 1978.

4) Originally assembled telephone sets; cable added to Amherst in 1977 and to Regina in 1976.

5) Down from (50-99) in 1976.

6) Down from (200-499) in 1976.

of PIC cable, the set-up time "is probably three times the running time." Western Electric's largest cable plant has an annual PIC capacity in excess of 50 billion conductor feet (bcf). Production at this one plant alone could supply the entire Canadian market. Mr. J.H. Stevens, Chairman of the Board, President and Chief Operating Officer, Canada Wire and Cable, testified that an optimum size could be found somewhere around 15 bcf. Northern's capacity at Kingston was put at 20 bcf, yet Mr. Millar indicated that further scale economies were obtainable with a larger plant. However, Mr. Millar noted that the plant was only operating at about three fourths its 20 bcf capacity. None of the Canada Wire and Cable plants produce more than 5 bcf of telecommunication cable annually, and Northern's small satellite plants have an estimated capacity of approximately one-half to one bcf.

There was some testimony indicating that beyond the rolling of the copper rod, scale economies are obtainable from the joint production of power cable and telecommunication wire and cable. Mr. Stevens noted that "the original stage of drawing the wire from the copper rod would use possibly the same machines". After that, much finer wires are needed for telephone cable than for power cable. However, Mr. Stevens testified that extruders could be shared:

> "You can use an extruder for jacketing or insulating a power cable, and you can use the same extruder for jacketing a telephone cable. . . . The equipment can be used, and the process concerned is similar in that it is an extrusion, but different in the method and type of extrusion."

Nonetheless, measured by employment, the largest Canada Wire and Cable plant producing telecommunication wire and cable is less than half the size of Northern's plant at Kingston.

While the geographical dispersion of several small plants can be motivated by savings in transportation costs, it is unlikely that savings from this source would outweigh the cost advantages obtainable in a larger plant. Although the smallest plants do not produce a full range of output (e.g., Northern's Regina and Amherst plants produce PIC cable up to 25 pairs), even this limited range could be produced more efficiently at a larger facility. Telephone company purchasing practices which give preference to local suppliers have prompted the establishment of local production facilities. While these purchasing practices yield the benefits that derive from dealing with local suppliers, one result is inefficient production in the small plants relative to the economies obtainable. The fact that the small plants in this industry are viable indicates that the prevailing prices are high enough to support inefficient production.

8. Optical Fibres

Recent developments in glass technology have led to the introduction of lightwave communication through glass fibres. Optical fibre transmission systems have many potential benefits. Their large bandwidth results in very high transmission capacities. Although the realized capacities are far below the theoretical potential, they are nonetheless impressive. Mr. J.A. Harvey, Assistant Vice-President, Technology Development of Bell Canada, reports that trial installations have demonstrated capacities exceeding 2,400 voice channels on a pair of fibres, which is far higher than the 24 channels on the commonly used copper pair cable systems. Fibre cables are smaller, lighter and more flexible than conventional copper cables of equivalent transmission capacity. This makes them easier to transport and install, and relieves underground congestion. Since no electric current flows through the glass fibres, they are immune to electrical interference. The power loss is lower than that for copper cables, and repeater stations can therefore be placed farther apart. Also, the fibres are made from one of the world's most abundant resources - silica or sand.

An optical fibre link consists of an optical cable and the associated system components. At the transmitting end of the link, elecrical signals are converted to light signals. The light signals are reconverted to electrical signals at the receiving end of the link. Light emitting diodes or laser diodes are used in transmitters as the light source; PIN diodes or avalanche photo diodes (APD's) are the light detectors. Other components of the system are the repeaters, which regenerate the lightwave signals when attenuation and dispersion cross threshold levels; the couplers, which combine the optical energy from two or more waveguides into one, or split the energy from one waveguide into two or more; the connectors, which connect the fibre to the optical source or detector. Splicing equipment enables fibres to be joined axially. Estimates and projections of production by component type indicate that the cable accounts for 55-60 per cent of system value, with the transmitters, receivers, repeaters, connectors and couplers accounting for the remainder.

Given the cost and quality advantages promised by optical fibres, it is not surprising that the technology has been tested in many countries, and that the conventional copper wire producers are interested in manufacturing fibre cables or fibre systems. Optical fibre systems have been tested as trunking installations, and also in the local loop, where their large bandwidth enables integrated voice, video and data transmission over a single subscriber line. The technology is moving very rapidly from trial to commercial applications. In the U.S., AT&T is building a network in its northeast corridor which reportedly connects about nineteen of Western Electric's No. 4-ESS digital long distance switching offices. This past summer the company announced its intention to introduce optical communication systems on five separate long-haul routes and sought proposals from various suppliers. The importance attached to the domestic development of the technology is indicated by the specification that the critical optical components such as the fibres, lasers, light emitting diodes and photo diodes must be manufactured domestically with final assembly of the major electronic components and cable to be in the U.S.

In Canada, the technology has been tested in many provinces. Bell Canada's Yorkville, Toronto field trial, using Northern equipment, was an early test of local loop applications. In 1980 Sask Tel announced it was building a $56 million 3,200 km system. Northern successfully bid for a $22 million contract to supply fibre optic cable and equipment for part of this project, and the company established an optical systems division in Saskatoon. Canada Wire and Cable has established an optical subsidiary, Canstar, and has participated in projects for AGT and MTS. Phillips is also active in this area.*

Turnkey fibre system installations are common, as telephone companies initially are interested in sourcing complete systems. Canstar supplied and installed the fibre optic cable and outside plant ancilliaries for a 55 km entrance link into Calgary, while Harris supplied the electro-optic equipment and served as the prime contractor. Lenkurt was prime and purchased cable from Phillips for a B.C. Tel trial installation. The fibre itself came from Corning, some being cabled by BICC and some by Phillips in Canada. As the telcos become more familiar with the technology, they can be expected to source components and cable separately and put together their own systems, as is the case with the more conventional transmission modes.

9. Competition in Equipment Supply

The evidence indicates that competition has been strongest in the category of transmission products. Entry into Canadian markets can easily be accomplished in voice frequency and digital multiplex through assembly or distribution. The per-unit value of products is relatively low and little engineering back-up is needed. Since the CRTC's interim decision regarding the interconnection of customer-owned terminals, there has been rapid growth in the number of distributors of terminals and in the products marketed in Canada. Until recently Canadian producers of central office switches were probably the most protected from foreign competition. Perhaps for the first time there is the potential for very strong competition in central office switching, resulting from the large number of European and Japanese suppliers who have set up in the United States. Having already made the necessary expenditures to modify their equipment so that it meets North American specifications, they are in a position to sell in Canada as well as in the U.S. The extent to which the U.S. has become a focal point for competition is particularly marked in the new fields of digital switching and cellular radio. Moreover, Western Electric announced arrangements in the Fall of 1982 to sell to the independent telephone companies through a number of distributors. With the transformation in the industry that has taken place as a result of changes in technology and industry structure the potential for highly competitive markets in Canada exists across all product categories.

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* Pirelli had not entered the field when the company appeared before the Commission in 1978.

CHAPTER III

VERTICAL INTEGRATION
BELL-NORTHERN-BNR

1. Description and History

Bell Canada, Northern Telecom Limited (NTL) and Bell-Northern Research Ltd. (BNR) are, respectively, Canada's largest telephone company, largest telecommunication equipment supplier, and largest industrial research and development organization. Although brief descriptions of these companies were provided in Part I of this Report, some elaboration is in order at this point.

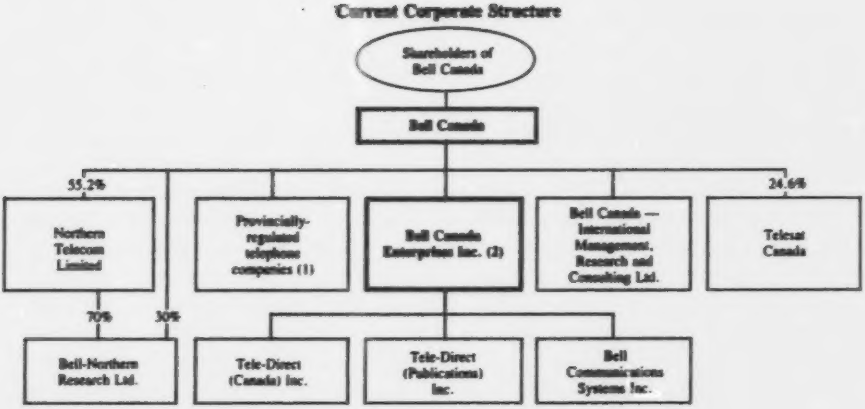
a) Bell Canada

The parent company is Bell Canada, which owns approximately 55 per cent of NTL (55.2 per cent at June 1982). Bell-Northern Research is a wholly owned subsidiary of Bell and Northern, with NTL owning 70 per cent and Bell 30 per cent of BNR's shares. Bell and its subsidiary and affiliated companies account for approximately 67 per cent of telephones in Canada and 60 per cent of telecommunication equipment purchases. Bell's operating territory covers most of Ontario and Quebec and some parts of the Northwest Territories. At year-end 1980, Bell had direct or indirect investments in more than 80 subsidiary or associated companies. The number of operating companies in which Bell has a direct interest is, however, much smaller; the principal ones are shown in Chart 2. The company has substantial equity interest in the principal Maritime telephone companies, and wholly owned subsidiary telephone companies serve parts of Ontario and Quebec. Bell also has approximately 25 per cent direct interest in Telesat Canada, and is a member of the TransCanada Telephone System. It owns an inter-

CHART II

BELL CANADA

CORPORATE STRUCTURE, JUNE 1982


Current Corporate Structure
Shareholders of Bell Canada
Bell Canada
55.2%
24.6%
Northern Telecom Limited
Provincially-regulated telephone companies (1)
Bell Canada Enterprises Inc. (2)
Bell Canada — International Management, Research and Consulting Ltd.
Telesat Canada
70%
30%
Bell-Northern Research Ltd.
Tele-Direct (Canada) Inc.
Tele-Direct (Publications) Inc.
Bell Communications Systems Inc.

SOURCE: Bell Canada, Notices of Special Meetings of Shareholders, Information Circular, Notice of Motion.

(1) Newfoundland Telephone Company Limited, 63.5% owned; Northern Telephone Limited, 99.8% owned; The Capital Telephone Company Limited, 100% owned; Télébec Ltée, 100% owned; Maritime Telegraph and Telephone Company, Limited, 35.4% owned; The New Brunswick Telephone Company, Limited, 35.8% owned.

(2) Formerly named Tele-Direct Ltd. Tele-Direct Ltd., formerly a wholly owned subsidiary of The Capital Telephone Company Limited, became a direct, wholly owned subsidiary of Bell Canada on June 11, 1982. Tele-Direct Ltd. was renamed Bell Canada Enterprises Inc. on June 22, 1982 and a new company was created named Tele-Direct (Canada) Inc. to carry on printing, publishing and related businesses.

national consulting firm, and, through its wholly owned subsidiary, Bell Canada Enterprises Inc., owns a directory printing company and Bell Communications Systems Inc., established in 1980 for marketing terminal equipment.

While Bell's telecommunication operations account for the largest segment of the company's net revenues and assets on a consolidated basis, its manufacturing and contract and other operations have recently exhibited rapid growth. Table 9 shows Bell Canada's revenues and assets by major category of operations for the years 1977 and 1981.

Bell Canada is subject to the regulatory jurisdiction of the Canadian Radio-television and Telecommunications Commission (CRTC). An allowed rate of return on equity capital (as determined for regulatory purposes) is used in calculating Bell's revenue requirements and hence its rates. Recent decisions concerning the regulatory treatment of Bell's investments in subsidiary and affiliated companies have in part led to a financial reorganization proposal by Bell Canada. Bell's proposal would segregate those activities not regulated by the CRTC from those associated with providing telecommunication services which are under the jurisdiction of that body. Investments in and income from the former activities would be transferred to a new parent holding company and Bell Canada would be the regulated subsidiary of the holding company. The proposal is discussed more fully in the final section of this chapter.

Bell purchases the major portion of its telecommunication equipment from Northern, its manufacturing affiliate and preferred supplier. A supply agreement exists under which Northern agrees, to the extent reasonably required for Bell Canada's business, to manufacture and sell materials to Bell, to prepare equipment specifications for Bell, and to perform installations, repairs, and other services as specified. Northern's prices to Bell are to be as low as those offered to other customers under comparable conditions.

TABLE 9

BELL CANADA SELECTED CONSOLIDATED FINANCIAL STATISTICS 1977 and 1981

	($ millions)		1981 as percentage of 1977
	1977	1981	
Telecommunications Operations			
Total Operating Revenues	2,241.7	4,035.1	180
Net Revenues	595.4	1,092.2	183
Assets*	6,065.0	8,821.6	145
Manufacturing Operations			
Sales	1,194.7	2,531.0	212
Net Revenues	121.0	187.4	155
Assets**	183.5	639.2	348
Contract and Other Operations			
Operating Revenues	76.8	823.8	1,073
Net Revenues	14.5	176.4	1,217
Investments			
Associated Companies and Non-Consolidated Subsidiaries	146.0	487.8	334
Other	2.3	6.7	291

SOURCE: Bell Canada Annual Reports: 1978 and 1981.

* Property at cost less accumulated depreciation plus land, plant under construction, and materials and supplies.

** Manufacturing and other property at cost less accumulated depreciation plus land.

b) Northern Telecom Limited

Northern Telecom Limited is active in two principal business areas. The first and largest is telecommunication equipment. Northern is involved in the design, manufacture and sale of a reasonably full line of telecom products, including central office switching equipment, subscriber apparatus and business communications systems, transmission equipment, wire and cable and related outside plant. More recently, Northern has diversified into electronic office systems (EOS), which involve the design, manufacture and marketing of computer terminals and peripheral equipment.* In 1980 the company employed approximately 31,900 persons: 18,600 in Canada, 11,500 in the U.S. and the remainder outside North America. Its principal operating subsidiary in Canada is Northern Telecom Canada Limited, which manufactures telecommunication equipment. Effective January 1, 1981, all the U.S. operations were consolidated as Northern Telecom Inc. (NTI).

At the end of 1980 the telecommunication equipment segment of Northern included: 27 plants in nine provinces in Canada, 13 plants in the U.S., and plants in Turkey, Brazil, The Republic of Ireland, and Malaysia. Recent additions include a Calgary facility for key systems, a plant in Saskatoon for fibre optics, a DMS manufacturing plant near Raleigh, North Carolina, and semiconductor plants in Ottawa and California.

Northern entered the EOS business in 1978 through the acquisition of two U.S. companies, Data 100 Corporation and Sycor Inc. Northern's EOS activities have remained in the U.S. In 1980 and 1981, Northern incurred operating losses in EOS, and in 1980 took substantial write-offs related to the purchase prices paid for these two firms.

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* Northern distributed electrical and electronic products until it sold its distribution company (Nedco) at the end of 1978.

Northern has recorded net earnings every year, with one exception, for the past 10 years. The exception was 1980, when heavy manufacturing start-up costs for Northern's digital systems, along with write-offs and expense provisions relative to EOS, resulted in a consolidated net loss. The company recovered in 1981, however, with earnings of $136.7 million on sales which had grown by 25 per cent from the previous year to exceed $2.5 billion. Retained earnings throughout the decade were generally high. Table 10 below shows consolidated sales and earnings for the company for the years 1977 to 1981.

Table 11 shows Northern's revenues and operating earnings (before general corporate expenses) by business segment and principal product lines for the years 1977-81. Although central office switching equipment previously ranked first in Northern's telecommunication sales, revenues from that source fell in 1978, when telco orders for the older generation of analogue switches dropped off while the carriers waited for the new digital switches. In 1981, revenues for central office switching equipment once again exceeded revenues for other product categories. The increase in this product line was chiefly due to an increase of over 93 per cent in digital switching sales.

Like other high technology companies, Northern spends substantial sums on research and development. Testimony has stressed the fact that its research is product (and market) oriented. During 1978-81, Northern's R&D expenditures exceeded seven per cent of its manufacturing sales. Earlier in the decade (1971-77), they averaged 6.2 per cent of such sales.

The Canadian plants produce telecommunication equipment for sale in Canada and for export. Most telecommunication products sold in the U.S. are manufactured

TABLE 10

NORTHERN TELECOM LIMITED
CONSOLIDATED SALES AND EARNINGS

	1981	1980	1979	1978	1977
Consolidated sales ($ millions)	2,570.9	2,054.6	1,900.5	1,504.6	1,221.9
Net earnings (loss) ($ millions)	136.7	(185.2)	113.5	100.7	85.3
Net earnings (loss) per share (dollars)*	3.95	(5.48)	3.70	3.55	3.22
Dividends per share (dollars)	1.00	1.00	.85	.74	.66

SOURCE: Northern Telecom Limited, Annual Report 1981.

* After extraordinary items.

TABLE 11

NORTHERN TELECOM LIMITED
BUSINESS SEGMENTS AND PRINCIPAL PRODUCT LINES

	1981	1980	1979	1978	1977
			($ millions)		
Revenues					
Telecommunications equipment					
Central office switching	776.0	505.1	386.0	338.9	412.6
Subscriber apparatus and business communications systems	739.9	618.6	524.7	374.3	275.3
Wire, cable, and outside plant	323.6	349.9	366.7	276.6	215.1
Transmission	409.0	277.6	227.3	141.3	114.5
	2,248.5	1,751.2	1,504.7	1,131.1	1,017.5
Electronic office systems	274.2	259.0	349.8	171.5	-
Electrical and electronic products distribution*	-	-	-	162.9	173.7
Other (principally research and development)	48.2	44.4	46.0	39.1	30.7
Total	2,570.9	2,054.6	1,900.5	1,504.6	1,221.9
Operating Earnings**					
Telecommunications equipment	301.8	187.4	234.5	180.9	184.6
Electronic office systems	(15.7)	(86.7)	26.0	30.0	-
Electrical and electronic products distribution	-	-	-	8.9	8.0
Other	2.1	3.5	1.7	-	-
Total	288.2	104.2	262.2	219.8	192.6

SOURCE: Northern Telecom Limited, Annual Report 1981.

* Business discontinued effective December 31, 1978.

** Operating earnings exclude general corporate expenses.

in that country. Mr. C.G. Millar, Executive Vice-President, Operations, Northern Telecom Limited, has indicated that, for the most part, the U.S. facilities rely on the Canadian main plants ("motherhouses") for product design and information regarding manufacturing processes. However, there are benefits to locating research and product development in close proximity to the market, and research and development work is carried out at U.S. manufacturing locations and at Bell-Northern Research Inc. Mr. J.D.M. Davies, Vice-President, Business Development, Northern Telecom Limited, testified that this is particularly true in the area of subscriber switching, where approximately 50 per cent of Northern's R&D was at U.S. locations. Northern's telecom acquisitions in the U.S. have retained their R&D capabilities, and account for a substantial share of Northern's U.S. telecom R&D. These acquisitions are Cook Electric (outside plant, transmission and information systems products), Northeast Electronics and Spectron Corp. (test equipment), and Danray, Inc. (computer-controlled switching systems for large business customers and telcos). Overall, Northern's telecom R&D is primarily conducted in Canada.

Markets outside of Canada have become increasingly important for Northern. The U.S. ranks foremost among these. Equipment standards in the U.S. are similar to Canadian standards and the U.S. market is more open than those of other developed countries. The U.S. is also a relatively important source of equity funds for the company, with over 60 per cent of non-Bell held shares owned by residents of that country.

Table 12 shows revenues by geographic location of the selling organization for the years 1977-81, and indicates the rapid growth of Northern's U.S. operations. Table 13 shows revenues by customer location for the years 1979-81, and gives a somewhat more precise indication of the relative importance of the different geographic markets for these three years. By 1979, more than half of Northern's sales were to customers outside Canada. By 1981, the U.S. market alone accounted for almost 41 per cent of Northern's consolidated revenues.

TABLE 12

NORTHERN TELECOM LIMITED
REVENUES BY GEOGRAPHIC AREAS

	1981	1980	1979	1978	1977
	($ millions)				
Canada					
Customers	1,334.6	1,084.0	1,000.8	1,007.9	1,014.4
Transfers between geographic areas	160.2	87.5	66.9	86.0	44.4
	1,494.8	1,171.5	1,067.7	1,093.9	1,058.8
United States					
Customers	1,047.0	807.0	739.6	447.1	193.5
Transfers between geographic areas	85.3	67.4	20.5	19.8	6.5
	1,132.3	874.4	760.1	466.9	200.0
Other					
Customers	189.3	163.6	160.1	49.6	14.0
Transfers between geographic areas	15.5	2.8	—	.9	5.9
	204.8	166.4	160.1	50.5	19.9
Eliminations of transfers between geographic areas	(261.0)	(157.7)	(87.4)	(106.7)	(56.8)
Total customer revenues	2,570.9	2,054.6	1,900.5	1,504.6	1,221.9

SOURCE: Northern Telecom Limited, Annual Report 1981; Securities and Exchange Commission, Form 10-K Northern Telecom Limited, 1979.

Sales by acquired companies, as well as increased penetration with Northern's product line, contributed to the growth of U.S. sales. In telecommunication equipment, figures filed by Mr. Davies show that Northern's sales in the U.S. market increased by approximately 370 per cent from 1976 to 1979. The increase, excluding acquired companies, was 215 per cent.

Canada is, nonetheless, Northern's major source of sales and in 1980 and 1981 accounted for approximately 49 per cent of Northern's consolidated revenues. Bell Canada is Northern's most important customer. As is shown in Section 3 below, Northern's sales to Bell during 1979-81 equalled almost one third of its total manufacturing sales, and 41 per cent, 36 per cent and 35 per cent, respectively, of its telecommunication sales.

TABLE 13

NORTHERN TELECOM LIMITED REVENUES BY CUSTOMER LOCATION

	1981	1980	1979
		($ millions)	
Canada	1,248.0	1,018.0	946.2
United States	1,052.0	793.7	753.1
Other	271.2	242.6	201.2
Total*	2,571.2	2,054.3	1,900.5

SOURCE: Northern Telecom Limited, Annual Report, 1981.

* Totals differ from previous tables due to rounding.

c) Bell-Northern Research Ltd.

Bell-Northern Research Ltd. does research, design, development work, long-range planning and systems engineering on behalf of Bell and Northern. The current ownership shares of Bell and Northern (30 per cent and 70 per cent respectively) reflect their contributions to BNR's operating revenues. BNR employed 2,210 persons in Canada at year-end 1980. A U.S. subsidiary, BNR Inc., employed 577 at the same date. BNR Inc. was established to take advantage of the skills concentrated in Silicon Valley and to tie in to Northern's U.S. operations. Most of its R&D relates to the requirements of Northern Telecom, Inc. The central BNR facility is in Ottawa, with other Canadian facilities in Toronto, Montreal and, most recently, Edmonton. The areas of activity contemplated in 1980 for the Edmonton facility included the development of transmission products which are meant to tie in with Northern's transmission marketing group in that city, the development of features for key systems to be manufactured in Calgary, some development work in optical fibre systems and systems engineering work. U.S. locations at year-end 1980 were Mountain View, California; Minnetonka, Minnesota; and Ann Arbor, Michigan. The last two locations were the result of the 1980 integration of research and development in EOS into BNR Inc. BNR telecommunications R&D is centered in Canada; the expressed intent was to continue this.

BNR is the focal point of the R&D efforts of Bell and Northern. Patents resulting from BNR's research and development activities are generally assigned to Northern under an agreement among Northern, Bell and BNR, to facilitate Northern's licensing activities. There are provisions for the division of resulting royalties between Bell and Northern. Although BNR has other customers, work for Bell and Northern dominates its activities.

Bell and Northern carry out internal R&D in addition to that funded by them at BNR. Northern's various manufacturing plants are responsible for its internal R&D. In recent years, internal R&D has accounted for

40 to 50 per cent of Northern's total R&D expenditures. The plants concentrate on manufacturing processes and product evolution rather than initial product design. Table 14 gives R&D expenditures for the Bell group of companies for the years 1978-79, as reported in the financial statements of these companies.

TABLE 14

BELL GROUP
R&D EXPENDITURES CONSOLIDATED

	1979	1978
	($ millions)	
Northern (Internal and BNR)	132.6	97.8
BNR for Other Customers (Principally Bell Canada)	45.9	37.6
Bell and Other Subsidiaries*	5.2	15.5
Total	183.7	150.9

SOURCES: Securities and Exchange Commission, Form 10-K Northern Telecom Limited, 1980; Bell Canada Annual Report, 1980.

* Figures cited by Mr. Harvey of Bell Canada and Dr. Hall of BNR during testimony are fairly close to those shown in the table with respect to Bell's total R&D expenditures, however they classify a greater proportion of Bell Canada R&D "internal" than does the above table. For 1979, Bell's internal R & D is given as $19.8 million, with $28.3 million at BNR. For 1978 the figures are $24.1 million internal, $27.0 million at BNR.

d) Relationship to the U.S. Bell System

Bell's and Northern's early ties to the U.S. Bell System have affected Canadian telecommunications. Bell Canada was partly owned by American Telephone & Telegraph Corporation (AT&T) for over 95 years. When Bell Telephone Company of Canada was formed with a federal charter in 1880, National Bell of the U.S. owned 25 per cent of the issued equity. The American company's share was 49 per cent at its maximum, dropped to 25 per cent by 1930, two per cent by 1970 and was eliminated in 1975. Northern Telecom Limited, which was incorporated as Northern Electric Company, Limited in 1914, was initially owned 56 per cent by Bell Canada and 44 per cent by Western Electric. Western's share in Northern remained at this level until 1957, when it dropped to 10 per cent. In 1962 Western divested itself of these remaining shares. In both cases Bell Canada acquired Western's shares and thus became 100-per-cent owner of Northern. Bell Canada's ownership of Northern has been reduced since 1973, when Northern became a public company. In June 1982 Bell's share of Northern was slightly over 55 per cent.*

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* Following Northern's public issue of shares in 1973, Bell's ownership was reduced to 90 per cent. In 1974 Bell issued 2,000,000 units consisting of convertible voting preferred shares of Bell and warrants to purchase Northern shares. In 1975 Bell offered over 5,000,000 common shares of Northern along with warrants to purchase 2,625,000 common shares of Bell. These transactions resulted in a capital gain of $126,554,000 to Bell's shareholders. In 1979 Bell agreed to purchase 2,000,000 shares of Northern. This left Bell with a 54.5 per cent ownership share of Northern, assuming the exercise of all outstanding warrants.

The ownership ties to the U.S. system entailed service agreements with AT&T and Western which influenced the course of Canadian technology. Under the terms of a service agreement with AT&T, Bell Canada had access to the U.S. Bell Laboratory telecommunication developments, to the maintenance, operating and administrative practices of the U.S. Bell System, and to AT&T for advice, discussion and training. Also, Western provided technical information on Bell System developments to Northern. This information linked basic design to manufacturing processes and to the final product. The equipment manufactured by Northern was generally of American Bell System design. Occasionally, as with step-by-step switches, the technology of other manufacturers was used. The manufacturing process was based on Western Electric drawings, with whatever adaptations were required for Canada. Northern first assembled purchased parts and then moved to the manufacture of components, thus gradually acquiring the manufacturing capability for any specific item. Dr. D.A. Chisholm, at the time of testimony, Executive Vice-President, Technology, Northern Telecom Limited, and now Chairman of the Board and President of BNR, Ltd., has remarked that in the late fifties:

> "Northern Telecom had been operating a branch plant of Western in the full sense of the word deriving its technology totally from the Western Electric Company in the United States, . . ."

The physical legacy of these years remains. Although new installations for Bell Canada are predominantly of Northern design, the proportion of such products in Bell's total plant is still low - only 10 to 15 per cent in 1980.

The 1956 Consent Decree in the U.S. changed Bell's and Northern's relationship to AT&T and Western. Its terms regarding the disclosure of technical information led to a concern at AT&T and Western that they might have to extend to all U.S. manufacturers the same information that Northern was obtaining. Accordingly, beginning in 1959, the Western-Northern Technical Information Agreements became progressively more restricted and costlier. By 1972 this flow of information had essentially stopped and in 1975 the final AT&T-Bell Canada agreement ran out.

e) Bell-Northern-BNR

The reduced flow of information from Western meant that Northern had to become more self-sufficient. An R&D division was established at Northern in 1958 and was later expanded. Internal company documents referred to in the Green Book indicate that staff of Bell Canada, who continued to get design information from Bell Labs into the seventies, sometimes pressured Northern to adapt these designs, thus inhibiting innovation. Initially, there was pressure to concentrate on more fronts than was possible, given Northern's early R&D capabilities, and also conflict, over acceptable levels of product quality. Finally, there was some conflict over the amount of resources that would be devoted to Bell's needs and the amount that could be used for non-Bell requirements and adaptations for export. Mr. A.G. Lester, who was Vice-President, Engineering, Bell Canada, from 1958 to 1965, and later was Executive Vice-President of Planning and Research, has treated these conflicts as basically start-up problems, which were resolved as Bell and Northern acquired experience with the new situation.

With R&D as a division of Northern, expenditures were Northern's responsibility. There was interest in establishing a system whereby Bell could directly provide R&D funds, particularly since Northern's R&D costs were rapidly climbing and because Bell was initiating R&D projects. In 1969 letters patent for the creation of BNR were granted; operations commenced in January 1971. Technical personnel from Bell and R&D personnel from Northern went over to BNR.

When originally established, BNR was owned 50 per cent by Bell and 50 per cent by Northern, reflecting the fact that Bell was an important source of funds for BNR in these early years. R&D expenditures at Northern, which had increased from $13 million in 1964 to $31 million in 1970, dropped to $29.7 million in 1971, the year that BNR commenced operations. In 1972 Northern's R&D expenditures were $28 million; it was 1973 before they surpassed the 1970 level. However, by 1978 Northern's contribution to BNR operating revenues had grown from approximately 50 per cent to 68 per cent. Bell's contribution, while increasing in dollar amounts, declined from approximately 40 per cent to 27 per cent. The equal ownership shares of Bell and Northern were changed to 30 per cent Bell, 70 per cent Northern by 1978 to reflect this. (See Table 15.) That is the level they remain at today.

2. Vertical Integration - The Information Exchange

a) The Process

The central benefit that Bell, Northern and BNR witnesses ascribe to the tri-corporate relationship is that it has fostered the development of innovative Canadian products. A number of Northern's successful products were given as examples. An important argument developed by the witnesses is that an on-going exchange of information and revision of ideas are central to successful product development, and that vertical integration facilitates this information flow. The tri-corporate innovative process and the development history of various Northern products were elaborated to illustrate this argument.

Recent economic literature concerning the nature of the firm suggests that it is useful to view the firm as an organizational form, which replaces external or market transactions between independent economic units with internal co-ordination and control. A case can be

TABLE 15

BNR
SOURCES OF REVENUE AND OWNERSHIP SHARES
1971 and 1978

	R&D FUNDED BY ($ millions)		BILLINGS* TO ($ millions)		SOURCES OF OPERATING REVENUE AS % OF TOTAL		INVESTMENT IN BNR INCOME DEBENTURES AVERAGE (%)	
	1971	1978	1971	1978	1971	1978	1971	1978
Bell**	16.5	27.3	16.6	29.5	41.0	27.0	50.0	30.0
Northern	18.7	56.3	20.7	73.2	51.0	68.0	50.0	70.0
Other	3.4	5.4	3.4	5.4	8.0	5.0	—	—
TOTAL	38.6	89.0	40.7	108.1	100.0	100.0	100.0	100.0

SOURCE: Written information to the Commission.

* Billings include expenses such as payments for computer time and building sample products.

** See Table 14, footnote.

made that common ownership provides an efficient governance structure for the development of complex products. Common ownership can reduce the danger of opportunistic use of information acquired for purposes of technological co-operation. Jointly owned economic units can minimize the risk associated with the uncertain outcome of R&D by relying on adaptive sequential decision making, whereas independent firms would have to use extensive contingent claims contracting; management decree replaces third-party litigation. The focus of Bell, Northern and BNR witnesses on the dynamics of innovation ties in with this body of literature.

Testimony has illustrated the flow of information and the fact that the final product is based on the combined knowledge of Bell, Northern and BNR personnel. The knowledge exists in people, studies, computer tapes, microfilm, standards and practices. Dr. C.D. Hall, at the time of testimony President of BNR, and now Executive Vice-President, Marketing and Technology for NTCL, notes that this knowledge includes the trade secrets and proprietary know-how of the manufacturer, operating company and R&D facility.

Although Bell's regulated activities should not require confidentiality, Northern and, to a lesser extent, Bell are active in competitive markets. The argument was advanced that vertical integration between Bell and Northern enables all parties to draw freely on the total knowledge-base and removes the need to either withhold information or enter into detailed contracts regarding its use. It was argued that such contracts can be costly and can also limit the future applications of acquired knowledge. This could seriously inhibit new product development in areas such as switching, where there is often a carryover of approaches from one product to another.

There was testimony regarding the formal working and steering committees, informal everyday contacts, and on-going transfer of personnel among Bell, Northern and BNR, which contribute to the information exchange.

There are, of course, the more obvious executive overlaps; i.e., Bell and Northern have one Chairman of the Board. The necessity for sequential decisions, with participants revising their perceptions of the final product (or service) as development proceeds, was stressed.

BNR, which performs R&D on behalf of both Bell and Northern, is a central contact point. Its design work draws on Bell's knowledge of operating requirements and on Northern's knowledge of manufacturing processes and general market requirements. Since Bell focuses on the operation of its network and future network developments and service offerings, BNR work for Bell involves network and planning studies. The results of these studies are made available to Northern. BNR also does work related to equipment requirements and evaluation for Bell. Northern focuses on its products. BNR plays a large role in product definition and development for Northern, as well as doing custom design work and software design. An important BNR role is its performance of exploratory work on new technology.

Although the project development format is said to be flexible, stages were outlined by Dr. Hall and Mr. J.V.R. Cyr, Executive Vice-President, Administration, Bell Canada, as a guide. When a new product or service opportunity is identified by Bell, Northern or BNR, Bell considers the potential application of the product or service in its network. Working with BNR systems engineers, Bell establishes desirable size, traffic capacity, operating features and costs, and estimates of the probable Bell market. Northern, applying its knowledge of general market conditions and of competing products, establishes product characteristics, price objectives and time schedules. BNR development staff explore the most promising technology. BNR systems engineers devise interface standards, performance requirements and maintenance features. The interaction among Bell, Northern and BNR personnel is said to be constant during this period.

These activities provide the knowledge necessary for the definition of the preliminary product or service. The most promising technology is defined and marketing plans and manufacturing capabilities are studied. Development investment decisions are based on these activities. Detailed definition and product development follow. If the project is major, BNR issues a Systems Requirement Document, which summarizes exploratory research results and covers features and technical requirements. By the time Bell issues a Performance Requirement Document (PRD), which is a formal (although not final) specification of its requirements, Northern and BNR have been involved in the product definition. Under the terms of Bell's procurement policies, Bell offers the "Opportunity of First Proposal" to Northern, which Northern generally answers positively.

During the product development stage, a project team is created in the appropriate Northern division, which establishes a development arrangement with BNR. Product development expenditures are said to be Northern's responsibility, although this is not the case when Bell is likely to be the only buyer of the product. Inter company committees operate during the development process. The product definition is subject to change in response to additional information on market opportunities, costs and technological variations. Technology trials and field trials follow.

The R&D effort does not stop with the introduction of a product. Northern's R&D expenditures on product evolution are often greater than its earlier outlay. For example, in the case of the SP-1, Northern had spent $22 million on R&D when the first office was put into service, but anticipated spending $100 million over the life of the product. By 1979, Northern's expenditure on SL-1 was more than double that spent up to the time of its introduction in 1975, and was projected to be five times that amount by 1983. Similar predictions have been made for the DMS family.

Bell witnesses have outlined the development histories of various Northern products to illustrate the tri-corporate approach. Included are the SG-1 or Pulse

PBX, the SL-1 Business Communications System, the SP-1, and the DMS switching family, the DRS-8 microwave system and Datapac. Although wire and cable R&D is basically carried out in Northern's cable division in Lachine, a close working relationship is said to exist between Bell and Northern.

Bell witnesses have indicated that one of the benefits they derive from their working relationship with Northern is their ability to influence the features of Northern's products and the timing of their introduction. In the course of testimony, examples of products developed with Bell (or Canadian) requirements in mind were given. The SP-1 electronically controlled switch was developed for the smaller centers for which the No. 1 ESS, a Western Electric design, was not suited. BNR designed and Northern supplied an 8 GHz digital microwave radio system (DRS-8). The advantage of this system to Bell was that it used existing 4 GHz analogue routes by overbuilding. This avoided the costs of additional towers, buildings, land and access routes. Since 8 GHz is not an available common carrier bandwidth in the U.S., the DRS-8 could not be sold in that market. In Canada it was sold to MTS, Sask Tel and AGT, as well as to Bell. Northern was initially reluctant to undertake development of the DRS-8. When it was developed, it was under a special arrangement whereby most of the development costs were recovered from Bell.

Northern witnesses, for their part, have stressed the fact that overall market potential is of prime importance to Northern. Its growing sales outside the Bell market support this contention and indicate that Bell's needs are viewed with the more general requirements of the market in mind. In the case of some of Northern's products, recent annual sales outside of Canada were eight or nine times greater than those in this country. This was true, for example, in 1979 for the SL-1 and DMS-10, both of which have been widely adopted in the U.S. The DMS-10 in fact was more suited to the U.S. than to the Bell market, since small U.S. offices were still using step-by-step technology when Bell had already introduced common control switching. In fact, the U.S. subsidiary, NTI, had the prime responsibility to manufacture and introduce this switch to the North American market. The DMS-250, Northern's newest digital switch, is a tandem switch for the specialized common carrier market in the U.S. Although the overall DMS family was developed in conjunction with Bell, as is set forth in the following section, to date its major market is outside this country. Northern's recent entry into EOS has been independent of Bell. While it might be true that Bell was the dominant force in Northern's early years, this can no longer be said to be the case. One effect of the entry of Northern into markets unrelated to Bell would be the declining importance of the information exchange between Bell and Northern.

b) DMS-100 and -200 Development

The DMS 100 is the large local digital switch and the DMS 200 is the digital toll switch. Initial exploratory work on digital switching technology began in 1968 when the Northern Systems Engineering group (which later became part of BNR) investigated the feasibility of applying digital time division switching technology to the network. In 1969 the group published a report predicting that advances in large scale integrated circuit technology would result in digital time division switching superseding analogue space division switching in less than 10 years, and recommending the development and introduction of this technology.

At around the same time (mid 1969), Bell and the research group assessed the long-term development of the total network in the 1975-85 time frame. In 1970 a report was issued recommending the development of a complete family of digital switching machines, starting with a toll switcher by 1978.

Northern, at this point, realized that digital switching was on the horizon and wanted to meet the competition. It was felt that a digital system would allow Bell to compete with data networks that might develop in Canada. More than four years of research followed. Bell provided service forecasts to BNR, whose staff undertook exploratory development work. BNR built a limited laboratory model to demonstrate digital switching techniques and to assist in developing cost estimates. In early 1973, BNR issued a Systems Engineering Prospectus recommending the development of a family of digital multiplex switching systems (DMS).

A tri-corporate decision to go ahead with DMS was made in late 1973. At this point Bell's forecast quantities and feature requirements were still not formally defined. Tri-corporate steering and working committees were established to oversee the project. Bell undertook further planning studies and, in co-operation with BNR, established its Performance Requirements Document (PRD). In early 1975, the project was again reviewed by senior management of all three companies. Major Northern-funded BNR development expenses commenced with the PRD. Forecast R&D expenditures exceeded $100 million and, at Northern's request, Bell assessed the impact of deferring introduction to 1985 to spread out the high development costs. Bell identified a long-term cost penalty to this and agreement was reached on a 1980 target date. Northern brought out the DMS-1 and the DMS-10 before the DMS-100 and -200, although the original plan called first for a toll switcher, which was the route that Western Electric had taken. As discussed in the section on central office switching, the competitive offerings to the U.S. were the smaller local switches, and Northern was an early and successful entrant to this market.

Although the PRD was forwarded to Northern in 1975, negotiations concerning features continued and the PRD underwent many changes. At the same time, BNR released a Systems Requirements Document to NTL, which described the design requirements for DMS in more technical detail. A technology trial unit was built by BNR in

1976, with staff loaned from Northern Telecom engineering and Bell Canada. Testing was a tri-corporate effort. The first verification was scheduled to be a DMS-200 toll switcher. Its specification was re-issued 12 times in six months. It was put in service in January 1979. The second system was a DMS-100 local switch, put in service in December 1979.

3. Vertical Integration - The Preferred Supplier Relationship

a) Purchasing Practices

Bell's purchases provide Northern with its largest and most secure sales. As Table 16 indicates, this is true even for the recent period (1979-81), when Bell Canada accounted for approximately one third of Northern's overall manufacturing sales and between 35 and 41 per cent of telecommunication equipment sales. In earlier years the figure was even higher. In 1976, Bell purchases accounted for almost 50 per cent of Northern's consolidated manufacturing and distribution sales and about 55 per cent of manufactured telecommunication equipment. In 1969 sales to Bell accounted for 58 per cent of Northern's manufacturing sales, and in 1964 such sales to Bell and the Canadian government were 78 per cent. These data relate to Bell Canada purchases only, and do not include the purchases of Bell's subsidiary and associated companies, who have always emphasized that they pursue independent purchasing practices.

Bell's reliance on Northern as an equipment supplier is greater than Northern's reliance on the Bell market. In 1969, Bell purchased almost 90 per cent of its telecommunication equipment from Northern. While this percentage has declined somewhat since then, payment data for the years 1975-78 show that over these years 80 to 85 per cent of Bell Canada's payments for telecommunication equipment were made to Northern.

TABLE 16

NORTHERN TELECOM SALES TO BELL CANADA

	1981	1980	1979
	($ millions)		
Manufacturing Sales to Bell Canada	794.6	630.9	616.0
Total Manufacturing Sales	2,522.7	2,010.2	1,854.5
Total Telecom Equipment Sales	2,248.5	1,751.2	1,504.7
Bell as %, Total Manufacturing Sales	31.5	31.4	33.2
Bell as % of Telecom Equipment Sales	35.3	36.0	40.9

SOURCE: Bell Canada Annual Report, 1981, and Northern Telecom Annual Report, 1981.

Table 17 breaks out these payments by product category. The level of aggregation understates Bell's purchases from Northern in those equipment areas covered by Northern's product line. For example, the payments in the station apparatus and transmission categories are affected by the fact that Northern does not supply teletypewriters, most data terminals, subscriber radio and light-route radio transmission products. Similarly, Northern does not supply line poles or underground conduit in the outside plant category.

The implications of Northern's preferred-supplier position were not fully apparent until Bell-Northern-BNR witnesses testified in the latter part of the hearings. As a preferred supplier, Northern is given the opportunity of first proposal. This means that Northern can provide proposals for new telecommunication

TABLE 17

BELL CANADA TELECOMMUNICATION PAYMENTS TO NORTHERN TELECOM
1975-1978

Payments by Product/ Service Category	1978	1977	1976	1975
Telecommunications				
Transmission				
Amount ($ millions)	84.1	76.0	85.7	95.0
(As % of Transmission Payments)	(75.5)	(75.0)	(77.2)	(83.3)
Switching				
Amount ($ millions)	178.3	231.0	217.4	191.2
(As % of Switching Payments)	(96.4)	(97.5)	(97.4)	(97.4)
Station Apparatus				
Amount ($ millions)	127.0	116.0	114.7	105.1
(As % of Station Payments)	(71.7)	(72.6)	(72.5)	(76.1)
Outside Plant				
Amount ($ millions)	149.0	125.0	110.7	83.0
(As % of Outside Plant Payments)	(76.5)	(79.3)	(77.0)	(78.3)
Telecommunication Sub-Total				
Amount ($ millions)	538.4	548.0	528.5	474.3
(As % of Telecommunication equipment)	(80.6)	(83.6)	(83.0)	(85.6)

SOURCE: Evidence of Mr. J.M. Thompson.

systems and equipment before other suppliers are requested to do so. Although Bell is free at any time to reject NTL's proposal and seek those of other suppliers, development with non-affiliated suppliers and/or outside purchases of telecommunication equipment in product lines covered by Northern is very rare.

Mr. Cyr noted that while Bell has experience in working with other manufacturers, it "has normally done so only in the data field, or where Northern Telecom has not expressed interest because of the lack of a sufficiently large market base." Mr. Cyr further indicated that, in the case of high capacity radio, switching and transmission systems, "outside purchase is rarely considered and then only if there are valid reasons, such as a gap in the Northern product line."

Mr. D.F. Hudson, Vice-President, Subscriber Switching, Northern Telecom Industries, Inc., elaborated the concept of a "gap". This can refer to a specialized piece of equipment that Northern simply does not produce, or to a situation where Northern has a product but another supplier develops one with additional features or superior technology. The existence of a gap does not necessarily mean that Bell will purchase an outside product. The company often chooses to wait for a new Northern product. An example of this policy appears to be present in Bell's purchase of digital multiplex equipment, which is discussed in Chapter VII. To quote Mr. Cyr:

> "Awareness of technology and availability of products from others does not alter the fact that for network elements Bell prefers to buy from Northern. In the usual case Bell or NTL will identify the need for the introduction of new technology and work within the tri-corporate structure to introduce the necessary products to meet network requirements."

Bell sometimes purchases equipment from other suppliers as an interim measure. For example, Bell purchased ITT's DM-32S digital subscriber carrier while at the same time participating in the development of the DMS-1. Mr. Cyr's testimony indicates that at the time the decision was made to purchase DM-32S, it was known that DMS-1 would eventually replace it, and that Bell purchased the ITT DM-32S in order to utilize the technology immediately. It is not clear how representative this case is.

The reason generally given for the preference for Northern equipment is that products developed within the tri-corporate structure are more suitable than those that are commercially available. The preference for Northern as a development partner is related to the tri-corporate innovative process, and specifically to the fact that Northern's existing knowledge of the network and on-going involvement with it means that product development will proceed more smoothly and quickly than would be the case with a non-affiliated supplier.

b) Price Evaluations

Bell's stated price objective when developing and introducing new products is to establish a price that will result in reduced life-cycle costs or increased revenues when compared to the existing equipment. It is not unusual for Bell to convey its general price expectation to NTL. Economic evaluation studies are undertaken to assess the advantage of new technology. In the case of products requiring tariffs, these studies are scrutinized by the CRTC.

Until the late 1950s, Bell evaluated Northern prices with reference to Western Electric prices. Northern was producing mostly Western designed products, and Northern's price to Bell was normally based on a markup over the Western Electric price to the AT&T operating companies. Northern was expected to stay within a given margin above the American price. As Northern became self-sufficient in product development, this approach had to be abandoned.

Bell's test of the reasonableness of Northern's prices currently rests upon monitoring compliance with the terms of a supply contract which was established in 1939 and amended periodically since then. The contract obligates Northern to supply Bell Canada with such materials as it may reasonably require for its business, although Bell is not obligated to purchase any such materials from Northern (then called Northern Electric). Article II of this contract reads in part as follows:

> "The Telephone Company will pay the Electric Company's prices for materials of Electric Company manufacture and for equipment specifications and installations as established from time to time; such prices shall be as low as to the Electric Company's most favoured customers for like materials and services under comparable conditions."

Bell thus obtains a price which is as low as Northern's price to other customers under comparable conditions. An annual audit by Touche Ross & Co. monitors compliance with the terms of this contract. The audit covers sales in Canada by Northern Telecom and its subsidiaries to Bell Canada and Canadian general trade customers. Subsidiary and affiliated companies of Bell Canada (other than NTL subsidiaries) are included in the category of sales to Canadian general trade customers. Sales to Canadian general trade customers are compared with sales to Bell Canada, as if Bell Canada had consummated an equivalent transaction.

Bell does not evaluate Northern's prices with reference to Northern's manufacturing costs. Bell witnesses have indicated that the company makes comparisons with other products, where possible. For example, Mr. Cyr has testified that development with Northern proceeds:

> "If it is judged that the end price at which the product can be offered by Northern will be better than what is available from other suppliers."

However, it is not clear that Bell pursues this information aggressively. Its knowledge of prices is often limited to list prices, and Bell's procurement policies specify that suppliers not be asked to quote in competition with NTL for telecommunication equipment. Prior to development, Bell's general awareness of the marketplace can be supplemented by issuing a Request for Information (RFI), which was defined as a request to suppliers for "preliminary information" rather than a detailed proposal. This was done when Northern's response to the opportunity of first proposal for a small modern switching office in the Northwest Territories was judged by Bell to be unsatisfactory. After evaluating an alternative proposal received in response to the RFI, and after Northern reduced its original price, Bell opted for the Northern product. The evidence does not suggest that this is frequently done and, given Northern's preferred position, it is doubtful whether other suppliers would be fully responsive to such requests.

Bell has taken the general position that its comparisons of alternative equipment offerings are subject to various limitations, especially in the case of complex and sophisticated items. Bell's response to Telecom Decision CRTC 78-7, in which the CRTC indicated that in future rate cases Bell would be required to furnish price and other information as to comparable equipment available from alternative Canadian suppliers in respect to major equipment purchases from NTL, was that its product information provides a useful backdrop to its procurement decisions, rather than a basis for a conclusive assessment:

> ". . . the nature and manner in which the information is gathered, and the judgemental nature of the process, are such that it generally would not permit the preparation of direct product-to-product price comparisons which could allow a conclusive assessment for purposes of specific procurement decisions or submissions to the Commission."

The Touche Ross audit provides a check on Northern's prices to Bell for those equipment items that are successfully sold outside of Bell Canada territory. The audit does not provide a check on Northern's prices to Bell for equipment where Bell Canada is Northern's only Canadian customer, nor is it adequate in cases where only a very few items of equipment have been sold to the general trade. However, Mr. Cyr testified that generally the greatest part of Bell purchases are in those product areas where Northern has been very successful. He said that only a few million dollars' worth of equipment is sold only to Bell. The audit would also not reveal cases where Northern lowers a previously higher price to Bell in order to obtain business.

In Telecom Decision CRTC 78-7, the CRTC extended the price comparisons to include NTCL exports and inter-corporate transfers. Bell Canada has objected, stating that export and inter-corporate transactions are not comparable to sales to Bell. In May 1981, the CRTC issued a public notice inviting submissions on the question of the most appropriate regulatory treatment to ensure that the prices paid by Bell for telecommunication equipment purchased from both NTCL and NTI are reasonable. The CRTC indicated that it is prepared to consider other regulatory approaches to supplement price comparisons, including competitive bidding for certain categories of procurement.

c) Suppliers Other than Northern

Mr. Cyr has described Bell's telecommunication purchases from suppliers other than Northern as being "more often than not . . . off-the-shelf items from the supplier." He cited the main categories involved: microwave equipment, test equipment, transmission products, outside plant, PBXs and data communication equipment. There are not many examples on the record illustrating Bell's procurement practices for telecommunication equipment supplied by firms other than Northern. The evidence of Mr. J.M. Thompson, Assistant Vice-President, Materiel and Automotive Equipment, Bell Canada, is that Bell uses a variety of procedures with non-affiliated suppliers. These range from requests for information, quotations or proposals where there are multiple vendors, through to preferred supplier and negotiated purchase from a single source. All these procedures can involve negotiations, which are entered into after bids have been received. Bell does not disclose the names of bidders, the price originally bid, or the final price agreed to, since public disclosure is felt to discourage low bids.

Bell has worked occasionally with non-affiliated suppliers. Dataroute is a case in point. When Bell had a short time frame in which to introduce an improved data communication service, a task force reviewed products and suppliers and chose to work with Computer Transmission Corporation (TRAN) of California. Tenders were not used. At the time, TRAN had a digital multiplexer in service in several private data networks in the U.S. The application was for use in the public network, and Bell worked with TRAN in developing this application, which was adopted for the TCTS network.

4. Vertical Integration - The Tri-Corporate Interface

There are many benefits that Northern derives from its relationship to Bell. The Bell sales base is a reasonably secure source of sales for Northern, many of whose activities are in the highly competitive U.S. market. Bell's R&D expenditures benefit Northern by expanding a common pool of knowledge. Bell's use of Northern's products provides a showcase for Northern, and reassures potential customers, who often want a proven product and some guarantee that it will be adapted to future carrier requirements. Many Canadian telephone companies have service agreements with Bell Canada, and information on Bell equipment - generally Northern's products - is disseminated in this manner. Northern's access to Bell's overall plans and detailed specifications gives the company an early and fairly complete understanding of telco needs. Witnesses have argued that the joint development effort is necessary for successful product innovation.

Bell witnesses have stated that Bell benefits from its relationship with Northern because it can tailor or modify equipment to suit its requirements. However, it is not clear that the company does this with Northern to any greater extent than a telco could with a non-affiliated supplier. For example, other suppliers in Canada and abroad were working on digital radio systems when Bell decided to develop the DRS-8.* It should also be noted that not all cases of tailoring equipment to Bell's requirements are in the interest of the subscribers. Bell, for example, chose not to adopt the least-cost routing feature of the SL-1, although it was available.

Bell witnesses (Mr. Inns and Mr. Cyr) have cited other advantages to Bell from its relationship with Northern. Many of these relate simply to the advantages to an operating company of standardizing on the products of a single large preferred supplier for most telecommunication equipment; i.e., priority treatment, efficient distribution channels, optimally matched generations of equipment, quality assurance and on-going support for equipment already in place. A high volume of transactions with Northern enables Bell to use a specialized material-management system and mechanized invoicing. Since Northern sells much equipment to Bell on an Engineered, Furnished and Installed (EF&I) basis and maintains detailed equipment records, Bell's requirement for engineering and associated staff is reduced.

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* Bell surveyed potential suppliers for this project. A stated reason for choosing Northern was a perceived time constraint. In the end, the introduction of the DRS-8 was delayed for two years.

5. Bell and Northern Performance

The only feasible means of evaluating the effect of vertical integration where an enterprise is fully integrated is at the level of delivery of the final goods or services. In the case of Bell and Northern, because Northern sells to a wider and growing market outside of Bell, it is possible to evaluate separately Northern's performance. It should not be taken that an evaluation at this intermediate level is sufficient, however, since inappropriate decisions by the telco can contribute to the positive performance of the equipment supplier while harming that of the telco.

With regard to product innovation, in 1970 only 10 per cent of Northern's manufacturing sales were of Northern proprietary design. By 1977 the figure was 75 per cent; in 1980 it reached 82 per cent. While it is difficult to assess the extent to which Northern's success derives from the free exchange of information that characterizes vertical integration and the extent to which it is due to other supporting features of the relationship, it is not difficult to conclude that the relationship between Northern and Bell has resulted in successful products.

A critical test of Northern's performance is its ability to compete in open markets. The most important of these markets is the independent telephone sector in the United States. It is least affected by subsidized credit terms which are found in international sales. It has also, in recent years, drawn the attention of most major suppliers. Northern's product offerings have been timely and sufficiently price competitive to capture appreciable shares of sales of PBXs and central office switches. Northern has also made significant sales of digital multiplex equipment and cable. Its most notable failure in the telecommunication equipment field is that it has not produced the small digital PBX which had been under development for several years.

Northern's annual reports for the years 1977-81 permit the operating earnings on telecommunication equipment sales in Canada, the United States and other areas to be calculated. Operating earnings, which exclude R&D and general corporate expenses, may be high, either because prices are high or costs are low. The results of the calculations are shown in Table 18.

Mr. C.G. Millar, Executive Vice-President, Operations, Northern, was asked, in December 1980, whether the data on operating earnings by geographic area implied that the gross markup in Canada was higher than in the United States. He stated that the difference in the two countries was due to the high start-up costs of a number of plants in the United States; i.e., the difference originated in cost, rather than in revenues.

Mr. Davies submitted confidential information to the Commission which compared prices in Canadian dollars, paid by Bell and quoted to telco customers in the United States, as of July 1979. These data show that the price to Bell was lower for most equipment, including PBXs and for most categories of central office switches. The comparisons were based on price lists used by Northern's staff to quote to customers; listed were items such as telephones and principal components of switches and transmission equipment required for a complete unit or system. Mr. Davies did not believe that the results were significantly affected by the fact that actual transaction prices were not used, since, if the prices quoted to customers had to be below list in order to gain sales, then the list prices were quickly changed.

The results of the price comparisons submitted by Mr. Davies are surprising, taking into account that there is evidence of increasingly strong market forces in the United States. Mr. Davies stated that Northern was able to demand a premium for some of its products, such as the DMS-10 and the SL-1, and thus it did not have to match unit prices of other suppliers; e.g., Nippon Electric. He also stated that the prices to Bell tended to reflect the competitive forces active in the United States.

TABLE 18

OPERATING EARNINGS AS A PER CENT OF TELECOMMUNICATION EQUIPMENT SALES*

	Canada	U.S.	Other Areas
1977	26.1	15.0	20.7
1978	25.4	20.6	14.5
1979	23.9	27.2	15.5
1980	23.4	9.1	16.4
1981	24.4	16.9	16.5

SOURCE: Northern Telecom Limited Annual Reports.

* Sales include only sales to outside customers; excluded are transfers between geographic areas, a tiny amount of intersegment sales of electronic office systems, and a small amount of intersegment sales of distributed electrical and electronic products. To arrive at telecommunication equipment sales and operating earnings in Canada, the 1977 and 1978 totals for the distributed product segment (electronic and electrical) are subtracted. This was before this product segment was sold. This entails the assumption that all sales from this segment are made in Canada. A similar treatment and assumption is required to arrive at telecommunication equipment sales after 1977 in the United States. In this case, it is the electronic office system segment that is subtracted, and it is assumed that all sales are made in the United States.

Transfers between geographical segments are made at cost and, as far as the Commission can determine, should only affect gross margins if there are cost differences between the regions. It would normally be expected that the region from which net transfers are made has lower costs than the receiving region, which would result in the latter enjoying higher margins than if it produced the output.

While the data in Table 18 should only be treated as suggestive, they are consistent with the structural differences existing in the United States and Canadian markets. Apart from the year to which Mr. Davies' price comparisons relate, 1979, when gross margins in the United States were temporarily higher, the differences were much larger, and ran the other way, in each of the other years. The margins were also remarkably stable in Canada, particularly in view of the recession which affected telecommunication purchases. The swings in gross margin in the United States are consistent with the costs of new capacity, but they are also consistent with the presence of competitive forces affecting prices. In this regard, it is noteworthy that Mr. Davies remarked that, for PIC cable, prices tended to respond much more to cyclical forces in the United States than in Canada, with price swings of the order of 20 per cent.

Sales from operations in other areas grew very quickly, from $14 million in 1977 to $189.3 million in 1981. The exact geographic distribution of the sales is not known. On average over the five years, operating earnings as a per cent of sales were about one percentage point below that in the United States.

In Canada, the Prairie telcos have been seen as a testing ground for the competitiveness of the vertically integrated suppliers, Northern, Automatic and Lenkurt. These markets provide a weaker test: there are few domestic suppliers in most equipment areas; there is a preference to deal with these suppliers on the part of the telcos; and there are fairly high tariffs. Since there is a high concentration of sales by a very few suppliers, these markets can only be characterized as competitive in relation to the situations that exist in the vertically integrated organizations. The real test of the effect of vertical integration on prices of telecommunication equipment is how prices in Canada compare to prices in the U.S. The available evidence on this comparison has already been reviewed.

There is abundant literature on how rate-of-return regulation may create incentives for firms to purchase equipment of a type or at a price that will not result in least-cost operation. The reasoning is not based on the existence of vertical integration, but it is consistent with and may be reinforced by it. Where the regulator allows the telco to cover at least its cost of capital, the telco has an incentive to increase the size of its rate base by using more capital-intensive methods than it would use in the absence of a ceiling on its earnings. The regulated firm is in a cost-plus situation in the long run. Thus, whether or not the regulated firm consciously responds to these incentives, there is no doubt that the discipline which exists for firms in competitive industries is absent.

The existence of vertical integration creates a burden on the regulator, who is faced with somehow policing the purchasing of the telco. One of the most important means of control has been, as noted earlier, comparisons of prices charged by Northern to Bell with those charged to its other domestic customers. Underlying these comparisons is the clause in Bell's supply contract which assures it a price as low as Northern charges other customers in like circumstances. The question, then, is whether there are any avenues by which vertical integration could have a negative effect on Bell's performance. The terms of the supply contract, other things being equal, would ensure Bell subscribers rates which were at least as low as those charged by other telcos. This is illustrated in the results of Touche Ross audits which show:

> "Percentage Relationship Between the Prices Paid by Canadian General Trade Customers and the Equivalent Prices Which Would Have Been Charged to Bell Canada from the Samples Selected for the Purpose of our [Touche Ross] Report on Prices Charged to Canadian General Trade Customers."

TABLE 19

PERCENTAGE RELATIONSHIP BETWEEN NORTHERN'S PRICES TO BELL AND TO OTHER CUSTOMERS
1972, 1975, 1978

Type of Equipment	1972	1975	1978
	Merchandise Sales (Bell = 100%)		
Central Office	111.9	109.6	105.3
Station Apparatus	109.5	104.4	106.3
Outside Plant	108.4	114.4	107.2
Other	108.3	110.6	106.7
	Contract Sales		
Switching	103.8	107.3	105.9
Transmission	109.2	108.9	102.1
Overall weighted average	106.7	108.7	106.0

SOURCE: Touche Ross audits.

Table 19 shows that Bell had lower prices in every equipment category and, overall, had a purchasing bill on Northern's equipment lower by at least six per cent in the three years; the average was just over seven per cent. Given that the gross return to capital (depreciation, interest on debt and earnings on equity) is somewhat over 40 per cent of Bell's operating revenue, the price advantage provided by Northern works out to a difference in total revenue (or cost) somewhat below three per cent. Of course not all capital on which a return is earned represents equipment purchased from Northern: equipment and structures are purchased from other suppliers, and a significant proportion of capital in place consists of a telco's labour inputs which have been capitalized.

The lower prices that Northern charges Bell are not likely to be discernible in comparisons between Bell's rates and those of other telcos. Firstly, the comparisons relate solely to equipment that other telcos choose to buy from Northern. There is likely to be at least some offset from equipment that Northern sells to Bell but which is not purchased from Northern by other telcos or is purchased in small amounts. Secondly, if vertical integration creates a potential cost disadvantage to the telco, it is more likely to be found in the direction of inappropriate equipment choices than in higher prices being paid for the equipment. The most controversial choice of equipment in Canada was B.C. Tel's decision to stay with step-by-step switches and pass over the crossbar switching technology. This decision was highly visible. This is not the case for most purchases, however, since it is very difficult for anyone outside the telco to evaluate purchases, as is illustrated in the discussion of digital transmission equipment in Chapter VII. Thirdly, the differences in the telco costs are so much affected by conditions particular to their operating area that, unless some way is found of allowing for them, they may swamp differences in prices paid for equipment.

Dr. Robert Babe, who appeared for the Director, presented evidence on an index of productivity in B.C. Tel, AGT and 'edmonton telephones', Sask Tel, MTS and Bell during 1967-76. He compared the progress of an index of subscriber rates with the inflationary effect of rising factor prices paid by the telcos over the period. If subscriber rates rose less quickly than factor prices, the difference was attributed to increases in productivity. According to Dr. Babe's index of productivity, B.C. Tel and Bell did not perform as well as the three government-owned telcos.

The difference in estimated productivity growth between the two types of telcos was attributed to vertical integration. Assuming that Dr. Babe's measure is an accurate index of productivity, vertical integration could contribute to the result if the integrated telcos, compared to the Prairie telcos, were paying increasingly higher prices, or were receiving increasingly less favourable prices for their equipment, or were buying increasingly unsuitable equipment. Alternatively, if higher prices were being paid or less suitable equipment were being purchased in the initial study year, the result could be obtained if the telco operations became more capital intensive. Measured roughly in purely monetary terms, there has been no increase in capital intensity - combined interest, earnings and depreciation were 42.4 per cent of operating revenue in 1967 and 40.9 per cent in 1976. With regard to prices, the overall results of the Touche Ross audit, shown in Table 19, do not indicate any decline in the favoured treatment received by Bell. Northern, Automatic and Lenkurt together account for such a large percentage of sales in the categories of equipment they produce that it is difficult to see how there is sufficient scope in equipment choice to allow both Bell and B.C. Tel to suffer slower relative productivity growth because of poor equipment choice. Moreover, much of telco equipment purchases and other capital investment are likely to have little effect on productivity. A very large part of telco investment consists of highly standardized wire and cable, outside hardware, and subscriber equipment, and of capitalized labour which is used in installing this equipment. However, if B.C. Tel's decision to stay with step-by-step switching did have an identifiable effect on its overall productivity over the period in question, there should have been a reversal in its relative productivity performance as it began to rapidly replace its step-by-step offices in the late 1970s.

Measuring changes in total factor productivity and accounting for these changes are very difficult tasks. The territories of the telcos are quite different and they underwent changes that were far from uniform with respect to growth rates and the offering of new services. For these important reasons, as well as for those discussed above, the Commission does not find Dr. Babe's evidence compelling.

A number of partial measures of comparative telco performance were presented in the inquiry; e.g., operating costs per telephone. To the extent that effective regulation depends on knowledge of the regulated entity, it is desirable that such partial measures should be supplemented by more general ones. What is required is an understanding of why rates charged by one telco are generally lower or higher than those charged by another. The desirability of having this knowledge is not restricted to regulators of vertically integrated telcos. It is in the public interest that there should be exchanges of information among regulatory bodies at all levels of government and co-operation in the design of ongoing research of telco performance.

6. Bell's Reorganization

Part II of this Report dealt with Bell's proposed reorganization. In it, the Commission made the following general recommendation:

> ". . . the public interest requires that a reorganization should not take place unless there has been full public consideration of the probable effects of the proposal, with respect to both subscribers and the telecommunication industry."

Such a public review by Bell's regulator, the CRTC, is scheduled to begin on February 1, 1983. A report on the CRTC's findings has been requested by the Governor-in-Council by the end of March 1983. Earlier, following Bell's announcement of its plans, the CRTC had issued a public notice asking for briefs to be filed by the interested parties. Bell's response to the 25 briefs received by the CRTC was filed September 27, 1982.

The key issue, from the viewpoint of this inquiry, relates to the relationship between Bell and Northern. One of the concerns raised by Bell's reorganization proposal is its financial impact on Bell's shareholders and subscribers. This concern does not bear on the desirability per se of the proposed reorganization, but on how the capital gains from the transfer of Northern shares should be allocated between Bell's shareholders and subscribers. The answer stems from the role subscribers and shareholders played historically in Northern's development in the context of the regulatory environment in which Bell operated. The Commission's views on this question have been expressed in Part II.

A second concern of the Commission relates to the conflict of interest on the part of Bell's management vis-à-vis shareholders in Bell Canada Enterprises Inc. (BCE) and Bell's subscribers. Equipment choice by a regulated utility affiliated with equipment suppliers is of course a central issue in this inquiry. In Part II the Commission discussed how the proposed reorganization could exacerbate the conflict of interest that is inherent when a regulated utility has affiliated equipment suppliers. After the proposed reorganization, it is the shareholders of BCE who benefit if Northern is supported to the greatest extent possible, yet management must ensure that Bell subscribers are served well and at the least possible cost. The conflict may not appear to exist at times when the telco is earning less than the allowed rate of return. But as long as the approved tariffs are, on average, set at levels which would allow the return on equity to at least equal the cost of equity capital, the conflict of interest is a continuing problem.

A similar problem now exists since a required return has been set by the CRTC on Bell's holdings in Northern and in other subsidiaries. The CRTC imputes this return in establishing Bell's revenue requirements for regulatory purposes. There is therefore pressure to ensure that the subsidiaries earn at least the required return. The proposed reorganization is, in good part, a response to the CRTC's requirement. Both Bell's motivation and the public policy questions raised when a company subject to rate-of-return regulation invests in competitive enterprises may be appreciated through a review of the background to the CRTC ruling.

B.C. Tel's acquisition of Automatic Electric (Canada) Ltd. provided the CRTC with the first instance where an investment in a competitive enterprise by a company subject to rate-of-return regulation threatened to increase subscriber rates. The CRTC's concern was that the purchase price paid for Automatic was too high and could financially burden the subscribers. As explained in Chapter IV, the CRTC dealt with this danger by imputing a required rate of return.

This approach to the protection of subscribers from the effect of investments outside the areas regulated by the CRTC was extended to Bell in its Telecom Decision 80-14 of August 12, 1980. The decision was a reaction to an investment by Bell of $100 million in Northern's shares in November 1979 which served to retain its majority position. The CRTC was concerned that the dividend flow from Northern associated with this investment would be well below the rate of return "commensurate with the inherent risk involved" in such an investment. The base against which the required rate of return would have to be earned "initially" was the original cost of the shares, although it is noted in the decision that this amount is well below "the book value of Bell's total equity investment . . . which included Bell's entitlement to Northern Telecom's retained earnings."

In Telecom Decision 81-15 of September 28, 1981 the approach adopted for Northern was extended to the other Bell subsidiaries and affiliated companies, save for Tele-Direct (Publications) Inc. This decision included retained earnings in the investment on which the required rate of return must be earned.

In setting the required rate of return, the regulator is faced with the difficult problem of trying to determine the risk that attaches to investments in the supply of telecommunication equipment or in other sectors, given that changes in the relative and absolute returns are constantly occurring. In this industry, the returns are particularly affected by the powerful forces of new technology and changing government policies in a number of countries.

The financial impact on shareholders and subscribers of the approach taken by the CRTC is considerable. The difference between the imputed rate of return and the allowed rate of return on equity, which has been about one per cent, applies to the total investment in subsidiaries. Additionally, Bell has argued that the measure of the cost to shareholders should take into account the embedded cost of debt which is much lower than the allowed return to equity.

Given the sole goal of freeing subscribers from the financial risks inherent in investments in competitive enterprises, Bell's proposed reorganization is an effective instrument. The conflict of interest facing Bell management under the proposed reorganization is, unfortunately, common to all attempts to insulate subscribers from the financial risks of ownership affiliations between equipment suppliers and companies subject to rate-of-return regulation. B.C. Tel subscribers were under no financial risk when GTE owned Automatic Electric (Canada) Ltd., but it was in the interest of B.C. Tel's majority shareholder, GTE, that B.C. Tel purchase from GTE's wholly owned equipment supplier. Following the acquisition of Automatic by B.C. Tel, the subscribers have been protected from financial risk by the required rate of return on the investment set by the CRTC. B.C. Tel's shareholders gain or lose based on AEL Microtel's profit position. Whereas before it was only the majority shareholder that stood to gain when B.C. Tel purchased from its affiliated suppliers, now all shareholders are in that position. The same situation currently exists for Bell since the CRTC's decision of August 12, 1980 applied the approach used for B.C. Tel's investment in Automatic to Bell's investment in Northern. In the case of Bell, however, the benefits from purchases by Bell are shared by Bell's shareholders with Northern's other shareholders.

The question of management motivation is one of degree. The pressure on the management of a rate-of-return regulated firm to purchase the most cost effective equipment may not always be present, regardless of whether there is an ownership link with suppliers. Also, it is clear from the information on Bell's purchasing in the past, when Bell's subscribers potentially benefited from the financial proceeds accruing to Northern, that Northern's equipment was always given preference. What is new in the present environment, which could make management motivation more important than it was in the past, is that the choice of equipment is now greater and promises to increase even more. Even small shifts in preference can make a considerable difference as the range of choice increases.

CHAPTER IV

VERTICAL INTEGRATION: BRITISH COLUMBIA TELEPHONE - AEL MICROTEL

1. Corporate Structure

B.C. Tel is the second largest telephone company in Canada, with approximately 11 per cent of the country's telephones. GTE has voting control of B.C. Tel through its ownership of the majority of the common stock of Anglo-Canadian Telephone Company.

GTE (U.S.) has been for years the second largest telephone holding company in that country, after AT&T. Its telephone companies account for approximately 10 per cent of the telephones in the United States, a figure which approaches the total number of telephones in Canada. It is a vertically integrated company with manufacturing affiliates and a research arm. GTE sells communication equipment to affiliated and non-affiliated telcos, government agencies, industrial companies, railroads and utilities. In 1976 GTE received over half of its telephone equipment revenues from markets outside the U.S. In addition to its Canadian operations, it has manufacturing facilities in Italy and Belgium and smaller facilities elsewhere.

Until 1979 GTE, through its wholly owned subsidiary, GTE International Incorporated, owned 100 per cent of the manufacturing firms, GTE Automatic Electric (Canada) Ltd. and its wholly owned subsidiary, GTE Lenkurt Electric (Canada) Ltd. In 1979 B.C. Tel acquired Automatic from GTE International and it was renamed AEL Microtel Limited. A research subsidiary, Microtel Pacific Research Limited, was established at the same time. Automatic Electric, which manufactured subscriber and central office switching equipment, became the subscriber and central office switching division of AEL. Similarly Lenkurt, which manufactured transmission products, became the transmission division of AEL. The combined sales of these companies in 1978 were $151 million, or one tenth of those of Northern. Distributed-product sales by Automatic of $21 million are included in this total.

2. Products and Technology Transfer

An AEL plant in Brockville, Ontario, manufactures central office switching equipment, related central office products, and PBXs. A Lethbridge facility manufactures telephones. AEL's subscriber and switching products include:

- residential and business telephone sets;
- central office switching equipment;
    - C-1 EAX, a stored-program analogue switch suitable for installations up to 7,600 lines;
    - No. 1 EAX, a stored-program analogue switch suitable for installations up to 45,000 lines;
    - No. 2 EAX, a stored-program analogue switch suitable for installations up to 25,000 lines, which provides CO Centrex service;
    - No. 3 EAX, a digital toll switching system; and
    - GTD No. 5 EAX, a new digital exchange which is a modular design and can be applied over a very wide range of line sizes.
- a line of stored-program digital PBXs (GTD-120, GTD-1000 and GTD-4600);
- TSPS, an automated toll traffic service position system;

- CAMA, a centralized automatic message accounting system;
- the Enterphone, a switching system used in apartment buildings and similar facilities.

AEL Microtel's transmission division, the former GTE Lenkurt Electric (Canada) Ltd., manufactures radio, multiplex and other transmission equipment in Burnaby, British Columbia. A Saskatoon facility, opened in 1973, manufactures digital multiplex equipment. A Winnipeg plant, opened in 1976, manufactures microwave radio equipment. The main transmission products are: analogue and digital multiplexers, light-route microwave radios and the System 51 supervisory and control equipment, which is applied on microwave routes and by utility companies.

Many of the products manufactured and sold by AEL Microtel were designed and developed by GTE.* This is particularly true in the area of switching and subscriber equipment. The EAX switches Nos. 1, 2 and 3, the GTD series of PBXs, and TSPS were developed by the U.S. GTE Automatic Electric and manufactured under licence by Automatic Electric (Canada). Mr. H.R. Herron noted that the Canadian market available to Automatic could not support the expenditures required to develop major switching systems. Two exceptions to Automatic's reliance on U.S. technology have been the C-1 EAX, which is a small analogue local switch, and the Enterphone.

The technology transfer is paid for by royalty payments and by technical and engineering fees. Data filed with the CRTC at the time of the acquisition indicated that Automatic's royalty payments to GTE International were over $2.3 million in 1978, which amounted to

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* The company also manufactures telephone sets and KTSs based on Western Electric designs.

2.8 per cent of manufacturing sales. Royalties were forecast to rise to over $3.5 million by 1983. Mr. Herron testified that any Automatic (Canada) inventions were vested in GTE and that the company was paying a royalty on the C-1 EAX even though Automatic Electric (Canada) had developed it. Lenkurt's payments were mainly in the category of technical/engineering fees, and amounted to $206,000 in 1978, or less than one half of one per cent of sales. Lenkurt (Canada) made significant improvements in the filters used in analogue multiplexers and developed the supervisory and control system (System 51). In 1978, Lenkurt employed 119 technical personnel, approximately twice as many as did Automatic.

Most recently, AEL has participated in the development of the No. 5 EAX, the new GTE digital switch. This was a joint undertaking with GTE, which was responsible for the major share of the work. Microtel's initial major research project was to design the remote switching unit for the No. 5 EAX.

3. Ties to the Parent Organization

B.C. Tel, Automatic and Lenkurt had strong ties to the parent organization at the time of the acquisition of the manufacturing firms by B.C. Tel. Automatic (Canada) reported to GTE Automatic (U.S.) and Lenkurt (Canada) reported to its U.S. counterpart, GTE Lenkurt (U.S.). Arrangements with GTE ranged from a service agreement between B.C. Tel and the GTE Service Corporation, under which technical assistance and operating information were provided to the telco, through to the overall co-ordination of the manufacturing, R&D and export marketing activities of the subsidiary companies. Data filed at the time of the acquisition indicate the amounts paid by Automatic and Lenkurt to the parent company in commissions, royalties, technical/engineering fees, advertising, and administration fees for the years 1974-78, and projected amounts for 1979-83. In 1978 these payments represented 3.2 per cent of Automatic's sales and 1.1 per cent of Lenkurt's sales.

Mr. E.V. Hird, President and Chief Executive Officer, Lenkurt (Canada), testified prior to the acquisition that plant location and expansion were determined by the management of Lenkurt in consultation with the parent company concerning capital appropriation priorities. Mr. Herron of Automatic said that, in deciding where the manufacture of specific equipment will take place, a bargaining process went on. Automatic would make a case to justify the capital investment required, but it was essentially a corporate planning decision. He went on to say that GTE's policy is to rationalize production. He stated that the Canadian telecommunication market was depressed in 1978 and that there would be a lot of excess capacity at Automatic if it were not for the fact that they were using some of their production capacity for the U.S. market.

The GTE Service Corporation played a co-ordinating role in R&D decisions. Mr. Herron indicated that telco inputs from the U.S. and Canada were co-ordinated by the Service Corporation and conveyed to Automatic (U.S.) at Northlake, Illinois, the focal point of GTE subscriber and switching activities. Mr. Hird testified that a technical Policy Committee assigned research and development work to Lenkurt (U.S.) or Lenkurt (Canada). The company also had close ties with GTE Laboratories Incorporated for the design of the large-scale integration chips necessary for their products. It was hoped that the acquisition would lead to more independently developed Canadian products.

Testimony heard immediately after the acquisition indicated continuing ties between GTE and the Canadian group. Under the agreement of March 1979 between GTE International and B.C. Tel, B.C. Tel was entitled to continue the arrangements existing between Automatic Electric and Lenkurt and GTE and its affiliates. Agreements with the parent company entitled the subsidiaries to a variety of technical services - i.e., inspection and testing of products at the parent's laboratory facilities and receipt of reports on new designs and developments released by the parent. Sales to the U.S. market continued to be made through Automatic and Lenkurt in that country, and access to markets outside the U.S. continued to be through GTE International. Common purchasing of electronic components was arranged and access to the parent's patents was expected to continue. One of the stated objects of the acquisition was to strengthen the links between B.C. Tel and its affiliated manufacturers, and thereby strengthen the level of Canadian direction and Canadian R&D. After the acquisition, a leasing arrangement was negotiated, based on the objective of undertaking more R&D in Canada, and paying for R&D with an exchange of R&D, as opposed to royalty payments. However, testimony did not indicate an ability to move rapidly in the direction of independent R&D. It was expected, in fact, that there would be a continuing reliance on the U.S. companies during the transition period.

4. The Formation of AEL Microtel

a) Markets, Products and Profits

At the time of the acquisition in 1979, Automatic and Lenkurt were major equipment suppliers to B.C. Tel. From 1974 to 1978, B.C. Tel purchased over 60 per cent of its equipment from Automatic and Lenkurt (See Table 20). Information available for 1975 on telecom purchases alone indicate that B.C. Tel purchased close to 70 per cent of its equipment from Automatic and Lenkurt. Purchases from Automatic and Lenkurt peaked in 1976, and dropped off sharply by 1978. Sales figures reported by Automatic and Lenkurt show that the main reason for this decline was a decrease in sales of central office and distributed products to B.C. Tel in the case of Automatic, and a decrease in multiplex sales to B.C. Tel in the case of Lenkurt.

TABLE 20

B.C. TEL EQUIPMENT PURCHASES

	1978	1977	1976	1975	1974
			($ thousands)		
Automatic	32,531	71,918	86,893	63,600	75,772
Lenkurt	6,507	14,821	15,778	15,318	9,625
GTEC and/or U.S. Subsidiaries	--	--	--	40	65
Other Canadian Suppliers	65,993	55,657	54,452	42,544	27,650
Other Foreign Suppliers	3,189	3,252	3,353	2,894	2,116
TOTAL	108,220	145,648	160,476	124,396	115,228

SOURCE: CRTC Interrogatory CAC 111 - Additional information. British Columbia Telephone Company proposed acquisition of GTE Automatic Electric (Canada) Ltd. from GTE International Incorporated. Includes purchases of material for construction and maintenance in the following categories: outside plant, central office, radio and multiplex, station and PBX, and other (including tools, test equipment, vehicles and furniture).

Sales data for Automatic and Lenkurt filed with the CRTC at the time of the acquisition indicate the relative importance of different customer groups to these companies (see Tables 21 and 22).*

B.C. Tel and its subsidiaries accounted for almost 55 per cent of Automatic's equipment sales over the years 1974-78. Automatic maintained fairly steady sales to other Canadian customers, but its total sales declined between 1976-78 as sales to B.C. Tel fell off.** A sudden sharp increase in sales to GTE mitigated the overall decline somewhat, however a study on *The Supply of Communications Equipment in Canada* by DOC notes that

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* Although the purchasing data reported by B.C. Tel do not match the sales figures reported by Automatic and Lenkurt, both sets of figures show the same general trends. The variances were explained as being caused by timing differences, the inclusion of B.C. Tel subsidiaries in the sales data, the exclusion of provincial sales tax in the case of Automatic, and both provincial and federal sales taxes in purchases from Lenkurt (CRTC 301(a)). The timing differences should tend to disappear if the figures are summed over the entire period. Over the five years, total purchases by B.C. Tel from Automatic were $330.7 million, which compares to sales to B.C. Tel reported by Automatic of $332.3 million. The comparable figures in the case of Lenkurt are $62 million and $51.8 million. About half the difference can be accounted for by the federal sales tax.

** B.C. Tel purchasing data show this occurred mainly during 1977-78. Automatic sales figures start the decline one year earlier.

TABLE 21

AUTOMATIC - TOTAL SALES - BY CUSTOMER

	1978	1977	1976	1975	1974
			($ millions)		
B.C. Tel and Subsidiaries	40.0	62.2	94.0	68.9	67.2
GTEC Canadian Subsidiaries	4.1	1.8	4.3	4.7	5.2
Other Canadian Customers	32.8	35.6	38.6	35.7	28.4
GTEC and its U.S. Subsidiaries	19.7	8.2	1.5	1.2	1.5
Other Foreign Customers	6.4	9.8	14.8	14.4	14.2
Total*	103.0	117.7	153.0	124.9	116.5

SOURCE: CRTC Interrogatory 300R, B.C. Tel Acquisition of Automatic Electric (Canada) Ltd.

* May not add due to rounding.

TABLE 22

LENKURT - TOTAL SALES - BY CUSTOMER

	1978	1977	1976	1975	1974
	($ millions)				
B.C. Tel and Subsidiaries	4.5	12.4	14.1	12.2	8.6
GTEC Canadian Subsidiaries	1.6	1.1	1.8	1.7	1.1
Other Canadian Customers	28.8	23.7	24.6	30.1	20.9
GTEC and its U.S. Subsidiaries	4.2	.4	.2	.2	.6
Other Foreign Customers	8.7	10.7	9.7	8.2	5.8
Total*	47.8	48.3	50.5	52.2	37.0

SOURCE: CRTC Interrogatory 300R, B.C. Tel Acquisition of Automatic Electric (Canada) Ltd.

* May not add due to rounding.

the increase in sales to the U.S. was due to a shortage of No. 2 EAX units in that country. Automatic was reluctant to forecast foreign sales beyond 1981 in its submission to the CRTC. Foreign sales outside the U.S. market declined over the period from 12.2 per cent to 6.2 per cent of total sales.

Lenkurt's sales peaked in 1975, however the decrease in its sales was far less drastic than was the case with Automatic. Lenkurt sold close to 80 per cent of its equipment to Canadian customers during this period, with the major part of these sales outside the GTE group. Except for 1978, its sales into the U.S. market were minor, but the company maintained fairly steady foreign sales outside the U.S. Projections to 1984 filed with the CRTC provided for increasing penetration of the foreign market outside the U.S. (CRTC Interrogatory 300R). Mr. Hird testified that Canadian transmission equipment is produced to standards which are more closely related to international standards than is American equipment, so that Canadian equipment is marketable internationally.*

Tables 23 and 24 show Automatic and Lenkurt sales by equipment category. Automatic's sales of central office equipment were affected by a shift away from electromechanical switches and by a general slackness in the Canadian market. Part of the decline in its sales of distributed products can be traced to the fact that it ceased distributing wire and cable for Phillips in 1977. Sales of an electromechanical PBX produced by Hitachi, Ltd., also declined with the introduction of electronic equipment.

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* Mr. Hird may have been referring only to microwave radio equipment.

TABLE 23

AUTOMATIC SALES BY EQUIPMENT CATEGORY

	1978	1977	1976	1975	1974
	($ millions)				
Subscriber	21.9	20.4	17.8	16.8	16.5
Central Office	60.2	68.6	81.5	55.1	46.4
Distributed	20.9	28.6	53.8	52.9	53.6
Total	103.0	117.7	153.0	124.9	116.5

SOURCE: CRTC 300R, B.C. Tel Acquisition of Automatic Electric (Canada) Ltd.

TABLE 24

LENKURT SALES BY EQUIPMENT CATEGORY

	1978	1977	1976	1975	1974
	($ millions)				
Radio	3.8	5.2	5.8	3.8	2.4
Multiplex	20.0	26.4	31.0	34.7	24.5
Other	24.0	16.7	13.7	13.8	10.1
Total	47.8	48.3	50.5	52.2	37.0

SOURCE: CRTC 300R, B.C. Tel Acquisition of Automatic Electric (Canada) Ltd.

Lenkurt's sales of multiplexing equipment declined after peaking in 1975. The most significant change occurred in digital multiplex, where sales to Canadian affiliates dropped from $8.9 million in 1976 to $1.5 million in 1978. This was due to the sharp reduction of the B.C. Tel interoffice trunking program, as a result of slower subscriber growth. There was a lesser drop in analogue multiplex to affiliates from 1976 to 1978, as the long distance calling growth rate did not decline as severely as subscriber growth. Sales of radio equipment, which had risen to $5.8 million in 1976, fell to $3.8 million in 1978. A slowdown in telco growth contributed to the decline, which Lenkurt partially countered by moving into the hydro utility market.

The consolidated statement of income for Automatic Electric (Canada) Ltd. for the years 1974-78 shows declining sales and sharply declining net income for that company from 1976 to 1978 (see Table 25). During the CRTC hearings on the acquisition proposal, it was noted that Automatic had embarked on a conversion program in its Brockville plant to enable it to produce electronic equipment efficiently. A return to profitability was forecast. The B.C. Tel Annual Report (1981) shows manufacturing operating earnings of $12.5 million in 1980 and $4.2 million in 1981 on sales of $188.4 million and $188.9 million respectively. These sales are approximately equivalent to projections filed with the CRTC at the time of the proposed acquisition.* AEL's sales to customers outside Canada, however, declined from $55 million (about 30 per cent of sales) in 1980 to $28 million (about 15 per cent) in 1981.

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* Low 1981 operating earnings are attributed to higher wage and benefit costs combined with flat sales due to labour disruptions.

TABLE 25

GTE AUTOMATIC ELECTRIC (CANADA) LTD. AND SUBSIDIARY SELECTED FINANCIAL STATISTICS*

	1978	1977	1976	1975	1974
			($ millions)		
Net Sales**	150.2	165.3	202.2	175.3	152.5
Operating Profit	1.3	3.8	13.3	14.2	15.1
Income (loss) before Tax Provision	(.06)	2.1	11.2	13.3	14.4
			(per cent)		
Net Income	.6	2.0	6.5	7.8	8.0
Dividends	—	3.2	3.0	4.0	2.0
Net Return on Equity	1.3	4.2	14.1	18.4	21.3

SOURCES: CRTC Interrogatory 235, CRTC Interrogatory 238a, B.C. Tel Acquisition of Automatic Electric (Canada) Ltd.

* Includes Lenkurt, at the time a wholly owned subsidiary of Automatic.

** Sales figures differ slightly from totals reported in previous tables.

b) The Acquisition

When in September 1979 the CRTC approved the application from B.C. Tel to purchase GTE Automatic Electric (Canada) Ltd. from GTE International Incorporated, it also approved the creation of Microtel Pacific Research Limited, the R&D subsidiary. GTE retains controlling interest of the Canadian group with its ownership, through subsidiaries, of just under 51 per cent of the total ordinary shares outstanding of B.C. Tel at December 31, 1981.

The main arguments advanced in favour of the acquisition can be summarized briefly:

- direct ties between the manufacturers and the operating company, along with the creation of the research subsidiary, would enhance the ability to perform R&D in Canada;
- rationalization of operations (i.e., in component design, production and purchase) between Automatic and Lenkurt, who were more and more becoming users of the same technology, would be facilitated;
- Automatic and Lenkurt would therefore become more aggressive and visible in the market;
- B.C. Tel would have direct input into the design of its equipment;
- B.C. Tel would have a broader and more diversified source of revenue;
- profits from B.C. Tel purchases would now flow to B.C. Tel, helping to hold rates down, rather than outside the regulated stream to foreign owners.

Under the terms of an agreement reached between GTE and B.C. Tel prior to the CRTC hearings, B.C. Tel was to purchase all of the issued and outstanding shares in Automatic Electric (Canada) Ltd. at a price equal to the value of Automatic Electric's shareholders' equity as of December 31, 1978. The book value at that date was $47.3 million. The regulator had to decide whether this purchase price represented a fair valuation of the firm's worth, since, if it were too high, it could create a deficiency in B.C. Tel's rate of return which would have to be made up by increased subscriber rates.

As already indicated, the net income of Automatic had declined substantially in 1977-78 (see Table 25). One objection to the proposed purchase, raised by the Consumer Association of Canada, was that the motivation for the acquisition could lie in the desire of the U.S. parent, GTE, to remove itself from direct association with a relatively unsuccessful manufacturing arm, while ensuring for itself a continuing market for its equipment.

The CRTC, after reviewing conflicting testimony regarding the value of the firm, concluded that on balance the purchase price of $47.3 million was high, possibly by a considerable amount. Approval, however, was granted. In an effort to protect the B.C. Tel subscribers from any financial burden that might result from the transaction, the CRTC decided to inpute a minimum rate of return on the average investment in calculating B.C. Tel's revenue requirement. At the time of the decision, the required return was set at not less than 15 per cent, with earnings in excess of 17 per cent excluded for regulatory purposes. The range was eliminated and the required return set at 17.5 per cent in the 1982 rate hearings. A continuing gap between the imputed and actual return could adversely affect indicators of B.C. Tel's financial integrity and increase its financing costs. The CRTC felt that the evidence indicated that short falls in the required return from Automatic could occur with some frequency in the next few years, and stated its intent to monitor Automatic's financial performance.

The acquisition raised the issue concerning the extent to which the British Columbia telephone equipment market would be open in the future. This issue was not a new one to B.C. Tel. Its equipment purchases had previously been of some concern due to the indirect ties between the operating company and its major equipment suppliers through the parent, GTE. B.C. Tel has consistently maintained that it does not give preferential treatment to affiliated suppliers. Nonetheless, a *Review of the Procurement Practices and Policies and the Intercorporate Financial Relationships of the British Columbia Telephone Company*, issued in July 1975 by the Department of Communications (Pelletier report), concluded that the procurement practice of the company from 1970-74 had been to purchase all hardware possible from its supply affiliates. In the five years 1970-74 inclusive, B.C. Tel was found to have purchased 82 per cent of its telecommunication hardware in four major categories from Automatic and Lenkurt. Outside sources of supply were used only when the affiliates did not have a suitable product available. In the case of electronic switching technology, B.C. Tel lagged behind other telecommunication carriers because their planning was influenced by the availability of this technology from Automatic. The report also criticized the purchase of B.C. Tel's wire and cable requirements from Phillips through Automatic Electric, which earned a commission. As mentioned earlier, B.C. Tel started purchasing its wire and cable directly in 1977.

During our inquiry, most of the testimony by suppliers regarding the foreclosure effect of vertical integration concerned the difficulty of selling to Bell. It does not follow that, on this account, the B.C. Tel market is open, since Northern produces a much broader product line than AEL Microtel, and thus many of the suppliers were direct competitors of Northern, but not of AEL. Mr. D.J. Hadley, President, Farinon Canada Limited, Lenkurt's competitor in light-route microwave radio, was of the view that B.C. Tel's market was closed to Farinon if Lenkurt produced a substitute product. Mr. H.A. Metzger, President of Bertus Industrial Limited, said that it was almost impossible to get information on B.C. Tel's future requirements. He said that a lot of effort was necessary just to get on their tender list. Bertus, which was located in British Columbia, had sales of $1.5 million. Mr. Metzger contrasted this with their experience with AGT, who always gave them ample notice of what type of equipment they intended to buy. Bertus supplied several specialized equipment items, such as cables and connectors between radio and multiplex equipment, and offered overhaul services of Telex terminals.

A related problem raised during the CRTC hearings on the acquisition proposal was that the required annual return on the investment would place additional and possibly undue pressure on B.C. Tel to purchase equipment from its subsidiary. Some suppliers also expressed concern over the effect of the acquisition on the flow of information on equipment requirements between AEL and B.C. Tel in comparison with the information that would be available to other suppliers.

In response to concerns regarding its purchasing, B.C. Tel proposed certain general rules which the company stated would set out its existing open procurement policy. Without concluding that the company's purchasing practices either had been or would be harmful to B.C. Tel subscribers, the CRTC directed B.C. Tel to file specific proposals and stated its intent to monitor the company's procurement practices.

An important aspect of the acquisition was the formation of Microtel Pacific Research Limited, which provides a focal point for the group's R&D effort. It was anticipated that both B.C. Tel and AEL would contribute R&D funds to Microtel Pacific. Mr. G.F. MacFarlane, President and Chief Executive Officer of B.C. Tel, indicated in 1979 that B.C. Tel was considering two alternative methods of funding the research subsidiary: jointly funding projects with AEL or fully funding projects and then entering into a licensing arrangement with

AEL. The contributions by the operating company and the fact that Microtel participates in joint R&D ventures with GTE raises two issues, both addressed by the regulator. First, how could the regulator ensure that R&D costs which should be borne by AEL are identified so that the true financial performance of AEL could be evaluated? Second, how could the regulator ensure that the Canadian group would not be used as a source of subsidy for the research efforts of the parent company in the U.S.? In response to the first issue, the CRTC directed that B.C. Tel be prepared to provide evidence on the breakdown of R&D expenditures by firm on a project basis, with the costs of joint projects allocated on the basis of use. In addressing the second issue, the CRTC noted that there was no indication that the value of the Canadian R&D would be compensated ("Indeed the reverse appears to be the case as payments to GTE in the form of royalties are forecast to increase significantly during the next 5 years.") (Telecom Decision CRTC 79-17). The CRTC therefore directed that Microtel should be encouraged to pursue a role independent of GTE as quickly as practicable.

There are several aspects to the decision that require comment. First, an imputed minimum annual return on an investment whose value is judged to be too high can place additional pressure on B.C. Tel management to purchase the equipment of its subsidiary. Second, it is not clear that competitive bidding would effectively counteract the pressures to purchase from a subsidiary, particularly in the case of complex equipment where managerial judgment is part of the process. Monitoring the results in such cases can present the regulator with many problems, as discussed in Section 5 below. Finally, at the time of the decision, Microtel's main projects were continuations of already on-going research. Given the limited nature of the Canadian market and the fact that AEL can only have access to the U.S. market through GTE, it is not apparent that Microtel will be able to pursue an independent course in R&D, particularly in areas requiring major expenditures. In 1980 and 1981, consolidated R&D expenditures associated with manufacturing totalled \$8.8 million and \$8.4 million, or 6.6 per cent and 5.2 per cent of sales. It is not known what part of these expenditures went to finance joint product development with the affiliated U.S. companies. With respect to independent product development, the level of expenditures indicates that the projects in question were fairly specialized.

5. Purchasing Procedures

The competitive purchasing procedures submitted by B.C. Tel to the CRTC establish four categories of equipment. These categories differ in terms of the complexity of the equipment, the availability of suppliers and the appropriateness of a formal tendering procedure. Category 1 consists of items where there is a clear-cut industry standard, and where the product can be purchased from a number of manufacturers or distributors, i.e., cords, jacks, plugs, installation hardware, outside plant hardware and telephone poles. Competitive tendering procedures are used for this category when purchases are expected to exceed \$50,000. None of AEL's products fall into Category 1, although it was indicated by B.C. Tel that telephones might be placed in this category. Category 2 consists of network-connected equipment with no future capacity for engineered additions, i.e., small stock-type PBXs, a number of transmission systems, most types of radios and telephones. Equipment specifications are normally available and interconnection with other equipment is based on well-defined industry standards. Competitive tendering with detailed specifications was proposed for this type of equipment. Most of AEL's transmission equipment falls into Category 2. Category 3 consists of complex equipment where systems or products are largely custom-engineered and can be expanded by engineered additions, i.e., all major types of central office switches and large PBXs. Requests for proposals were to be used for this type of equipment. In all these categories, bidding is by invitation only. Category 4 consists of additions to existing complex equipment and other purchases where specific technical requirements can only be met by one supplier. A Request for Quotation was proposed for such cases. Categories 3 and 4 cover the major part of Microtel's subscriber and central office switching product line.

B.C. Tel emphasized that the acquisition of complex systems often requires a dialogue between the telephone company and the supplier. The operating company describes the equipment in general terms and suppliers are asked to make proposals. A request for proposals was favoured in these cases, since the more formal tendering procedure, as the term was used by B.C. Tel, requires the precise specification of all relevant product characteristics, and costs rise as the number of requirements and complexity of specifications increase.

The purchasing department selects the equipment in Category 1 based on the information supplied. The engineering department evaluates the tenders or proposals in Categories 2 and 3. The final decision in these categories is the responsibility of the chief engineer, and is based on a variety of technical and economic considerations. Like other telcos, B.C. Tel looks at factors other than the initial price of a product when choosing equipment. Some of the more frequently mentioned considerations are compatibility with the existing networks, features, options, the costs associated with maintenance, expansion, training and installation, and energy and environmental requirements. The availability of the equipment, previous experience with the supplier, and the degree of support provided by the supplier (i.e., documentation, location of spare-parts inventory) are also mentioned. In addition, B.C. Tel gives preference to Canadian manufactured products. All of these are considered by B.C. Tel in evaluating equipment in Categories 2 and 3. While initial purchase price is the key determining factor where the equipment is relatively simple, a more sophisticated analysis of life-cycle costs is used in other cases.

B.C. Tel has submitted that its purchasing proposals merely formalize already existing procedures. The fact that so many variables enter into equipment evaluation for Categories 2 and 3 makes regulatory monitoring of the implementation of competitive purchasing in these areas difficult. A further difficulty lies in the fact that the object of a joint development effort is to develop a product which best meets the requirements of the participating telco. Since one of the goals of the acquisition was to establish the dialogue that would lead to these products, it is to be expected that any resulting products are assured a market with B.C. Tel.

6. Price Evaluation

In its telephone rate hearing of 1980, B.C. Tel submitted that it received prices from AEL which are the same as or lower than those given to other customers. B.C. Tel said that it gets preferential treatment on major system purchases. There is no document or formal agreement on purchasing, as there is in the case of Bell Canada and Northern Telecom.

In 1975, the Pelletier report found that the prices paid by B.C. Tel to its affiliates were reasonable. Lenkurt had a uniform pricing policy. Automatic charged B.C. Tel a price that was at least as low as that paid by other customers. The report noted that this finding was of limited value for step-by-step switches, since, over the period studied, B.C. Tel was Automatic's largest customer and sales to non-GTE affiliates were not considered to be of sufficient volume to allow a conclusive price comparison.

CHAPTER V

PURCHASING PRACTICES BY TELECOMMUNICATION CARRIERS WITHOUT AFFILIATED SUPPLIERS

There are similarities in the purchasing practices of telecommunication carriers without affiliated suppliers. Apart from CN and CP all of the carriers give some preference to suppliers on the basis of their location. The provincial telcos stated that they gave geographical preference in the order of province first and country second. In no case was it stated that a higher-cost alternative would be selected because of geographic preference. The effect of geographic preference is thus up in the air, since prices, product design and other variables taken into account when selecting a supplier are rarely going to be the same for complex products. Geographic preference can only be a factor if in fact it is given some weight that can offset other factors. The principal manufacturers obviously believe that it is in their interest to spread their plants so that they are widely represented in the territories of their customers. Northern has facilities of one kind or another throughout the country. AEL Microtel has facilities in each of the Prairie Provinces. Wire and cable suppliers have made it a point to locate plants in a number of provinces. It is unlikely that plant dispersal is motivated by savings in transportation since there are significant economies of scale in production. In Manitoba, ITT is chosen to supply telephone instruments on the strength of its telephone assembly plant that is located in that province. It is not known how the price paid by MTS compared with that paid by other telcos.

Although 'edmonton telephones' is not one of the companies which stated that it provided geographic preference, Northern Telecom was given the opportunity to resubmit a bid on switching equipment. The principal competitor in that case was A.E.I., which was offering a switch by a Japanese manufacturer, Nippon Electric Co. On the strength of its considerably modified bid Northern was awarded the contract. There was considerable controversy surrounding this purchase by 'edmonton telephones' since it makes public the bids it receives. Whether or not Northern's second bid was lower than the one initially submitted by A.E.I., or whether the Japanese manufacturer was bidding at an extraordinarily low price for purposes of penetrating the Canadian market, were points of consideration during the hearings. The fact that a second bid was accepted makes the first of the above points largely irrelevant. The second point is of some importance with regard to the level of prices for stored-program switches (Northern's SP-1). If A.E.I.'s bid was not based on penetration pricing by its supplier, it would indicate that Canadian prices were considerably above the level at which switches could be obtained from foreign suppliers. The fact that Northern was relatively successful with the SP-1 in the U.S. shows that Northern was able to price sufficiently low on a continuing basis to meet offshore competition, but except for 1979 it is not known how prices in the U.S. compared with those in Canada. More generally, the episode serves to reinforce the commonplace observation that there is a great advantage to being the last supplier approached, particularly when the supplier knows the terms it has to meet. Thus a customer's preference for a particular supplier, whether based on geography, ownership or past performance, can be a considerable advantage to the supplier.

Another point worth noting about purchasing practices is that telecommunication carriers generally do not make public the bids received. 'edmonton telephones' is an exception, since it operates under the same rules that the city uses in its general purchasing. The evidence regarding Manitoba Tel was less clear. It apparently moved to publishing bids some time in the 1970s.

However, whether or not bids received are published, telcos often provide feedback to suppliers so that they can know whether their bids had been competitive or wide of the mark. In wire and cable, AGT discloses to suppliers the range of discounts given. Overall, the Prairie telcos appear to be more open than those in the Atlantic Provinces to offerings from a wider number of suppliers. Although Bell has a substantial equity interest in the Atlantic telcos, whose testimony is that this in no way affects their purchasing decisions. The fact that the Prairie telcos appear to be more open could be the result of plant location and the fact that the telcos on the Prairies are larger and, in the case of AGT, better able to evaluate alternative equipment offerings. In any event, Table 2 shows that a much higher percentage of the Atlantic telcos' equipment needs are satisfied by Northern than is the case with the Prairie telcos.

Many of the telephone companies standardize on complex items of equipment for a two-to-three-year term to reduce equipment support costs -- i.e., operating and maintenance training, and spare-parts inventory -- and compatibility considerations. Many of the companies emphasized that they look at overall equipment costs rather than at the original purchase price alone. Standardization is a way of reducing life-cycle costs.

All of the TCTS member companies, except B.C. Tel and AGT, have service agreements with Bell Canada which give them, for a fee, administrative and technical practices, consulting services and other assistance. The question of the degree to which the Bell practices, which relate predominantly to Northern's equipment, influence the equipment choices of the other telephone companies was raised during the course of the hearings. The Atlantic telcos stated that this information did not bias them in favour of Northern's products.

An interesting area of telecommunication carrier purchasing relates to the purchase of equipment tailored to meet a specific telco's needs. Both CNCP and the member companies of TCTS have had to find suppliers they could work with in developing their data services. Except in the case of CN, this part of telco purchasing was not dealt with in the testimony of the telcos. It is clear that systems and equipment can be tailored without vertical integration. A good example is provided by the extensive fibre optic system that Sask Tel, in co-operation with Northern, is installing. Farinon also worked with Sask Tel, and later with Bell, in developing Farinon's subscriber radio system. AGT has, and is now, engaged in several development projects with suppliers. The first mentioned in the inquiry was a tone-to-pulse converter which would permit the use of touch-tone telephones in exchanges where the switches did not respond to tones. AGT selected Mitel from among those who had responded to AGT's request for proposal. During the course of development, AGT provided personnel and facilities for product testing and evaluation. It also contributed to financing the patent application and it shares in royalty income. The product in question, Mitel's "Quadverter", was selected by Bell's Quebec Region.* AGT also worked with Mitel to develop a system that would provide rural party-line subscribers with privacy. AGT is now engaged in one of the most ambitious projects undertaken by a telco in Canada, a joint-ownership participation in Westech System Ltd., with International Systcoms and A E S Data Ltd., for the development of a cellular radio system. Westech is also interested in other areas, such as developing communication between word processors.

The following sections discuss the information received from the telecommunication carriers regarding their purchasing practices.

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* The Ontario Region selected Northern's Digipulse, which performs the necessary conversion in the telephone instrument.

1. Canadian National Telecommunications (CNT)

CNT operates public telephone services in rural Newfoundland through its subsidiary, Terra Nova Telecommunications Inc. (Newfoundland Telephone Company Limited serves the populated areas). Its other subsidiary telephone company, Northwest Telecommunications, operates in the western part of the Northwest Territories, the Yukon, and a portion of northern British Columbia. CNT (with CPT) provides other telecommunication services, i.e., Telex and Infoswitch.

CNT is a division of CNR. CNR's bylaws require CNT to apply a competitive bidding system whereby sealed tenders are used for contracts of $25,000 or more. There are two types of tenders; the first is called a "public" tender. These are advertised in the press and are used in situations where there are a large number of possible suppliers. This category primarily involves construction items, such as buildings, bridges, towers, and telephone ducts.

The other class of tender is the "request for quotation". This request entails general specifications which cover technical standards and operating needs. It is sent out to a number of qualified bidders who would normally use products they have in stock to meet the need. The general purchase specification can be used repeatedly and is changed once every few years depending on the rate of progress in technology. On major items, the general specifications might be accompanied by what is called an "application specification". This outlines the special requirements for a particular application. It was estimated that 85 to 90 per cent of all equipment procurements were covered by these two processes.

Mr. C.G. Webster, Chief Engineer of CNT, agreed that they might not go to competitive tendering for expansion of capacity, since problems were introduced in mixing equipment from different manufacturers. However, if prices quoted for extensions appeared to be excessive and could not be justified satisfactorily, they would go to tender to obtain compatible equipment from another manufacturer. Mr. Webster said that they had not had experience with this kind of "razor blade pricing" so far, but they were preparing to open up the extensions to multiplex equipment on a competitive basis.

When a new product is required for a project, CNT prepares a functional specification, presents it to several firms, and invites them to make proposals based on their own designs. When awarding the contract, CNT uses a formal tendering process in which the firm whose design CNT has accepted is again only one among many in the group invited to tender.

In Mr. Webster's opinion, the competitive system gives the most favourable price available. He felt that the effort involved in evaluating equipment and proposals was justified as the spread between the lowest and the highest bids was often quite large and companies that had lost the bid would often subsequently adjust their prices. He also said that the lower bid often does not come from the largest company. On cross-examination, Mr. Webster agreed that they had no real experience with any other system of purchasing.

Mr. Webster described the steps involved in going into the market to purchase multiplex equipment. First, a purchasing specification is prepared. Next, an application specification is made relating to the specific project, then the CN purchasing department, situated at CNR's headquarters in Toronto, requests proposals from a list of bidders supplied by CNT. The purchasing department might add other companies to this list. After the proposals are evaluated, the firms who had the most favourable proposals are invited to submit equipment for evaluation. At this point, a recommendation on which company should receive the order is made and a decision is reached on whether this equipment should be the standard for a period of time. Multiplex purchasing differs from the purchase of wire and cable, for example, since in the latter case there is no need for standardization, and they go out regularly each year to tender.

Mr. Webster said that when they tender for a switch they usually receive only two or three bids. He cited the example of Gander, Newfoundland, where Northern Telecom won with its SP-1. Twelve companies were invited to quote. The only quotations received were from Northern Telecom, Automatic Electric, and North Electric, a U.S. subsidiary of ITT.

Mr. Webster said that in the competitive bidding process they look at the total cost implication, including training and maintenance costs, and not just the quoted purchase price. Most often the biggest influence is the purchase price, and the other costs help to make a determination if purchase prices are quite close.

2. Canadian Pacific Limited (CPT)

According to Mr. J.G. Sutherland, President, CNCP Telecommunications, CPT uses a tendering process involving the development of detailed specifications for the purchase of complex systems. In his view, the time and effort involved in working with detailed specifications is justified since it is better that CPT, and not its suppliers, should define what the company's needs are. Moreover, he felt that comprehensive specifications are welcomed by manufacturers since they simplify negotiations in the complex field of telecommunication procurement.

3. Telesat Canada

Mr. H. McGuire, Manager of Systems Procurement for Telesat Canada, described his company's competitive tendering procedure for satellites and earth stations as follows. First, a letter of interest is distributed to a large number of suppliers. It briefly outlines Telesat's requirements and asks if the supplier is interested in being a prime or a subcontractor. (Telesat deals directly only with the prime contractor.) Some preliminary screening of the responses is done at this point. A "request for proposal" is then prepared. It is a detailed specification of the requirements and is sent to potential prime contractors. These firms are also advised of who the interested subcontractors are. Within two to four months the proposals come in. The factors considered in their evaluation are price, Canadian content, technical capability and contractual responsiveness. The last factor involves the willingness of the suppliers to agree to terms such as Telesat's preference for fixed price contracts (versus cost-plus contracts) and delivery guarantees. When the prime contractor is chosen, a negotiation stage ensues which lasts for five to six months. This involves a dialogue to clarify the supplier's technical and contractual proposals to ensure that they coincide with Telesat's needs. The final contract is the outcome of this process.

Mr. McGuire said that for satellites the policy is that the prime contractor must maximize the Canadian content to the extent practicable. As discussed in Chapter II, Spar is the sole supplier of transponder equipment in Canada. For earth stations, a minimum of 60 per cent Canadian content is specified. For less complex equipment, i.e., test equipment, a "request for quotation" is issued to a number of firms which meet Telesat's requirements and the lowest bidder is awarded the contract.

4. TransCanada Telephone System (TCTS)

The TransCanada Telephone System co-ordinates the planning of its member telcos in matters concerning the national long distance network which they provide. TCTS issues a construction program based on the members' forecasts of traffic; thereafter, the member telcos take over and TCTS has no more control over the program. It was stated that equipment selection is entirely in the hands of the individual telcos, but the equipment must meet TCTS's specifications insofar as long distance traffic is concerned. The specifications influence the telcos' purchases in that TCTS standards are more stringent than those used by the telcos for intra-member and adjacent-member long distance services. Performance and quality are monitored, and the co-operation of the participating members is relied on for compliance.

TCTS sends copies of the technical specifications which it develops to interested manufacturing companies to indicate the way it wants the network to evolve, and in the hope that the manufacturing firms will develop equipment suited to its plans. TCTS avoids identifying the equipment of any particular manufacturing company as being capable of fulfilling its specifications, and tries to avoid actions which would permit any firm to monopolize equipment which it specifies. The specifications that TCTS evolves are not of the sort that can be used directly to draw up a tender for competitive bids. However, TCTS aids member companies which request help in drawing up a tender.

TCTS does not enter into contracts with manufacturing firms on its own behalf, or on behalf of its members. Contract arrangements between telcos have, however, emerged from discussions at TCTS meetings. In these instances, one telco selects a piece of equipment, and, acting as prime contractor for the group, arranges to purchase on behalf of all the interested TCTS members. This allows them to take advantage of discounts on volume purchases. These arrangements most often involve terminal equipment such as is used in data transmission.

5. Alberta Government Telephones (AGT)

The brief submitted by AGT stated that AGT's purchasing policy relied heavily on competitive tenders from both Canadian and foreign suppliers to obtain the best price consistent with quality and service. AGT felt that telephone companies do not need a large variety of suppliers, rather, they need a minimum number of suppliers, at least two, with the capacity and ability to serve AGT's current and long-term needs. AGT likes to have at least two alternative suppliers to ensure a reliable supply and to maintain a reasonable price competitiveness. Other factors being equal, AGT gives first priority to Alberta suppliers, then to other Canadian suppliers, and then to North American suppliers. AGT has discontinued a service agreement with Bell.

6. 'edmonton telephones'

'edmonton telephones' acquires equipment through the City of Edmonton's purchasing department. A city bylaw requires that all purchases in excess of $50,000 be made through a tendering process, whereby bids are solicited by advertising or invitation to particular suppliers and the bids are opened in public. The award of a tender to other than the low bidder can be made only on approval by City Council. The lowest tender is defined as the one that meets the city's specifications at the lowest overall cost of acquiring and operating the equipment over its useful life. A manufacturer's location is of minor importance. 'edmonton telephones' does not usually try to negotiate a successful bidder's price downwards, if the bid comes within the budget allocation.

Mr. G.K. Foster, General Manager of 'edmonton telephones', said that the competitive bidding procedure is a workable procedure and is to the advantage of 'edmonton telephones', although it creates some difficulties in making repairs and in stocking spare parts.

There is no connection between the purchasing practices of Alberta Government Telephones and 'edmonton telephones', although the two companies have joint planning and engineering committees to ensure compatibility of equipment.

7. Saskatchewan Telecommunications (Sask Tel)

Limited information on the purchasing practices of Saskatchewan Telecommunications was given in its written submission to the Commission. It was stated that Sask Tel is free to purchase from any supplier that meets its requirements, and that, as a result, it has purchased from a wide variety of suppliers. Sask Tel indicated that the necessity of compatibility arising out of the connection arrangements of TCTS imposes contraints on the design and operation of Sask Tel's system. It was added that the member companies of TCTS had on occasion pooled their purchases of a low-volume item to attract a Canadian supplier. This has not been done very often and therefore it is not likely to have had a significant impact on suppliers.

8. Manitoba Telephone System (MTS)

The representatives of Manitoba Telephone System explained that it is general policy that the purchase of material, equipment, and other contracts be subject to a public invitation to tender, or by formal request for quotation to competitive suppliers from an approved supplier list. In either case, the tenderers must respond to MTS specifications. It was stated that there is public opening of bids, but bids were not made available to the Commission. Mr. J.E.H. Elvidge, Assistant General Manager of Raytheon Canada Limited, believed that the public opening of bids had only recently been introduced by MTS.

There are two equipment categories corresponding to the two types of tenders:

- mechanical, which can be readily made by numerous manufacturers;
- network, such as switching and microwave equipment, which requires more sophisticated analysis of value.

It was stated that in both cases the factors considered are similar, but for the latter much greater emphasis is placed upon the manufacturers' records and prospects, and on an overall economic evaluation.

Lists of approved suppliers and products are subject to continual surveillance and update by the general staff engineer. MTS tries to identify at least three suppliers of each product, although it has undertaken competitive bids with just two suppliers. In cases where the equipment required has just one manufacturer, MTS will contact other telcos with similar or identical equipment to help assess the fairness of the price.

Mr. S.G. Anderson, Vice-Chairman and Assistant General Manager of Manitoba Telephone System, said that he felt their purchasing policy allows them to attract a wide range of suppliers in many areas, especially that of wire and cable, and that the tendering process reduces the cost of equipment.

Mr. D.J. Hadley, President of Farinon, said that, compared to AGT and Sask Tel, MTS places a greater emphasis on price in that they generally take the lowest bidder. AGT tends to do an exhaustive search initially and then standardizes on a piece of equipment, while MTS does not standardize. He added that larger telcos tend to have a more formal standardization process. However, Mr. Herron, of Automatic, said that while 'edmonton telephones' tends to standardize in the case of central office switches, AGT, MTS and Sask Tel engage in competitive bids from a preferred bidders list.

Mr. Hadley said that MTS gives preference to suppliers located in Manitoba. Mr. Herron cited the example of the preferred purchase of telephones from ITT, who have a manufacturing facility in Winnipeg. Nevertheless, Mr. Herron said that with MTS, one is more likely to see a very large number of responses to a bid than in the case of AGT and Sask Tel.

Mr. Hird, of Lenkurt, said that (for microwave and multiplex equipment) the Prairie telcos differ in the methods used for competitive bidding. MTS calls for bids on every job, while AGT conducts an extensive evaluation initially and calls for bids on very large quantities, normally standardizing for two or three years.

Mr. W.J. Wyler, General Manager of Comtest Communications Products Limited, said that MTS buys all its test equipment on a competitive bid basis and there is a strong emphasis on price. The other Prairie telcos usually invite competitive bids initially, then have a number of follow-on orders which are not bid separately.

9. Amtelecom Inc.

Amtelecom Inc., formerly The Aylmer and Malahide Telephone Company Limited, is one of the largest independent telephone companies in Ontario. The General Manager, Mr. R.B. Barnard, testified that the company calls for tenders on any significant purchases.

10. The New Brunswick Telephone Company, Limited (NBTel)

According to Mr. G.E. Graham, Vice-President, Planning, the use of competitive bidding is of relatively little importance in his company's purchasing practices, except for construction of buildings and for commodities such as gasoline or oil. However, NBTel had purchased a microwave system by tender, since, in Mr. Graham's opinion, the equipment was not very complex and there were a number of suppliers.

According to Mr. Graham they had not found competitive tendering to be a very satisfactory means of acquiring high technology items, which were not uniform among suppliers and which required extensive evaluation. Also, for complex equipment each application tends to be specific, as in the extension to a switch. In the case of complex equipment, NBTel calls for proposals and chooses the one that promises the lowest cost over the long term, both for operation and expansion of services. For items such as telephone sets and wire and cable, price is the key consideration.

NBTel allocates from three to five per cent of its wire and cable purchases to Phillips Cables Limited. Canada Wire and Cable Limited could supply all of NBTel's requirements, but the telco wishes to ensure supply in the event of an emergency, such as a strike. This is the only instance in which NBTel makes a conscious policy of allocating a percentage of its requirements to a supplier.

11. Maritime Telegraph and Telephone Company, Limited (MT&T)

Mr. S. Robertson, President and Chief Executive Officer of Maritime Telegraph and Telephone Company, Limited, said that MT&T only uses public tendering for items like gasoline and vehicles. For other purchases, MT&T secures bids from suppliers on the understanding that MT&T will not necessarily accept the lowest bid. If it does not find the lowest bid acceptable, it will negotiate with one or two of the other bidders to try to arrive at an acceptable price.

The primary factor considered by MT&T in purchasing is life-cycle cost. Other factors are compatibility with existing equipment, continuity of supply, inventory costs, and availability of operating procedures for maintenance. Location of the plant within Nova Scotia would also be a factor, other things being equal.

12. The Island Telephone Company Limited (Island Tel)

Maritime Telegraph and Telephone Company Limited owned 44 per cent of the stock of Island Tel (May 1978). Mr. I.E.H. Duvar, Chairman and President of The Island Telephone Company Limited, is also an officer of MT&T.

Island Tel calls for tenders when constructing public buildings and towers. Only those firms which Island Tel ivites may tender and generally the lowest bid is accepted.

Other requirements come under a system of "competitive quotations". The engineering department establishes a list of firms which Island Tel invites to tender. Much of the important work of analysis and appraisal is undertaken on a contract basis by MT&T. Island Tel has a foreman who works with the staff of MT&T to arrange delivery and supply of materials. Island Tel contracts the planning of facility expansion and the associated design and engineering to MT&T. Mr. Duvar claimed, however, that Island Tel, rather than MT&T, decides what quotations to accept, and that Island Tel could reject a piece of equipment chosen by MT&T. In the case of station and outside plant, Island Tel has contracted MT&T to purchase directly, and it relies on MT&T to purchase Island Tel's requirements of cable. Island Tel has a service agreement with MT&T.

13. Newfoundland Telephone Company Limited (Newfoundland Telephone)

Mr. A.A. Brait, President and Chief Executive Officer of Newfoundland Telephone Company Limited, said that their general policy is to use competitive tenders on items such as furniture, land, and buildings, but not for telecommunication equipment. For the latter, competitive quotations are invited and handled by the engineering department.

There are, however, exceptions to this general purchasing policy. Mr. Brait described how a step-by-step extension to a central office in Wabush had been undertaken using competitive tenders. The two suppliers involved were Automatic Electric (the successful candidate) and Northern Telecom. Mr. Brait explained that in this case the technologies of the manufacturers were very similar.

Newfoundland Telephone purchases goods that it uses in small volume, or that it needs in emergencies, through Bell Canada's material management system. Newfoundland Telephone's requirements under this arrangement come from Bell Canada's inventories.

Most of Newfoundland Telephone's equipment purchases are from Northern Telecom. It was felt that Northern had the lead in technology in cable, telephone sets, heavy-route microwave and switching. Mr. Brait stated that Bell Canada does not exert any pressure on Newfoundland Telephone to buy Northern's equipment. Northern has a warehouse and a small manufacturing plant in St. John's that makes some components for switching systems.

CHAPTER VI

MARKETS IN OTHER COUNTRIES

Outside North America, telecommunication services are typically provided either directly by the government or through public corporations subject to government control. In 1980 approximately 96 per cent of the world's telephones outside this continent were connected to these systems. The figures are shown below in Table 26.

TABLE 26

GOVERNMENT CONTROLLED OR OWNED TELEPHONES

	Percentage of telephones government controlled or owned	Millions of telephones government controlled or owned	Millions of telephones in geographic area
North America	2	4	192
Europe	98	173	177
Japan	97	53	55
Rest of World	90	45	50
World Total	58	275	474
Total Outside North America	96	271	282

SOURCE: Based on figures in Northern's Product Handbook and AT&T's publication, *The World's Telephones.*

In North America, private ownership of telephone systems predominates, with carrier operations subject to regulatory scrutiny. This high degree of government involvement in telecommunications results from the fact that, until quite recently, these services were largely provided under natural monopoly conditions and monopoly positions were thus legally conferred within geographic areas.

A protectionist attitude is characteristic of those countries outside North America which have an established telecommunication industry. The government authorities that provide telecommunication services procure their equipment locally and promote domestic production. Foreign technology is often obtained through licensing. With the exception of the recent steps taken by Japan, discussed below, procurement of telecommunication equipment is not subject to the GATT Agreement on Government Procurement, nor has the 1976 European Economic Community agreement concerning goods contracted by public authorities been applied to telecommunications. Public procurement in this sector is thus not generally covered by international agreements requiring non-discriminatory treatment of foreign firms.

Various telco authorities undertake joint technical research and product development with selected domestic suppliers, many of whom have a long history of association with the telco. These joint efforts may involve substantial government funding. While a close relationship serves to minimize the transaction costs of obtaining complex equipment that is compatible with unique network requirements, it also has the effect of supporting the chosen suppliers. Indeed, differing network specifications can be regarded both as a cause and as a result of separate national markets.

In the United States, vertical relationships between private service providers and manufacturers have, to date, effectively foreclosed most of the telco market for equipment. The vertical structures also provide the integrated manufacturer with detailed information on telco needs and are a source of joint research and development effort. A recent AT&T-Justice Department accord, which calls for the divestiture of the local operating companies by AT&T, should make the local companies more accessible to non-affiliated suppliers. AT&T Long Lines, however, which provide most of the long distance service in the U.S., will remain with the parent company.

Although there have been pressures to open up markets in other countries, rapid change is unlikely in the present recessionary environment. In December 1981, the foreign ministers of the 10 European Economic Community countries rejected an ECC Commission proposal to recommend that the national authorities open up 10 per cent of their public network procurement annually to suppliers of telecommunication equipment located in other member countries. One problem reportedly concerned the equipment of non-European-based suppliers who produce within the ECC. In fact, the swift pace of technological change that now characterizes this industry has led many countries to regard telecommunications as a high technology industry whose indigenous growth and export potential should be fostered. The developing areas of the Far East, Middle East, and Latin America are prime markets, as is that part of the North American market which is not foreclosed.

The following examples are illustrative.

1. Western Europe

a) United Kingdom (26 million telephones)*

The British telecommunication authority, until recently the British Post Office (BPO), now British Telecom, has traditionally worked with and purchased equipment from selected domestic suppliers, several of whom might be authorized to supply a given product. The General Electric Company Limited (GEC), Plessey, and Standard Telephone and Cables (STC), until recently wholly owned by ITT, are principal suppliers who have worked with the BPO over the years. Other suppliers include Thorn Ericsson (a joint venture between the Swedish firm and Thorn Electrical Industries), Pye/TMC (a joint venture entered into by a Philips of Holland company which received a BPO development contract for a modern key system) and British Insulated Callender's Cables Ltd. (BICC), which has worked with STC, GEC and Plessey on a fibre optics program for the BPO. Although the recent *Telecommunications Act* allows for the development of a more competitive service and equipment market in Britain, British Telecom has increased the number of firms from whom it is willing to buy terminal equipment. Mitel Corporation has won PBX contracts with British Telecom and has established production facilities in the United Kingdom.

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* All figures are estimates at January 1, 1980.

Britain's encouragement of the indigenous development of technology for domestic use and export is exemplified by System X, an advanced all-electronic digital switch. In the mid-1970s the BPO commenced joint development of System X with GEC, Plessey and STC, all of whom had participated in an earlier joint development effort - the Joint Electronic Research Council - in the sixties. System X has been funded by the British telecommunication authority. A recent article in *The Economist* states that the amount spent by British Telecom is at least 200 million pounds.

Britain's competitiveness in world markets was weakened by the strategy of the Post Office, which attempted to by-pass crossbar development and proceed directly to an electronic design. System X attempts to regain Britain's leadership position in telecom, and the level of exports achieved will be a measure of its success. A nationalized joint marketing company has been formed to market System X internationally. There have been, to date, no major export sales reported, which critics claim is a reflection of over-engineering and a faulty reading of telco needs. System X, nonetheless, illustrates what can only be described as a mercantilist approach to the purchase and sale of telecommunication equipment. Not only are suppliers from outside Britain virtually foreclosed from sales to British Telecom, but its funding of major development relieves its suppliers of the burden of this heavy cost.

In October 1982, ITT reduced its holdings in STC to 35 per cent. The announced corporate intent was to seek public equity ownership in major telecommunication subsidiaries serving predominantly local markets. British Telecom and STC also agreed that STC will have the exclusive supply for five years of the firm's analogue TXE 4A central office switch. At the same time STC will phase out its development work on System X, and will be free to market ITT's competing product, the System 12 digital central office switch, in the U.K. Industry observers had previously remarked on the difficulties facing the subsidiary's participation in the joint development and marketing effort for System X while ITT was offering System 12.

b) France (21 million telephones)

In the mid-seventies France embarked on a modernization program which rapidly transformed its telecommunication network. At the same time, telecommunication technology was brought under the control of French-owned firms. Government-sponsored efforts led ITT and LM Ericsson, who held large market shares in the French telecommunication industry (ITT's LMT, 26 per cent; ITT's CGCT, 18 per cent; Ericsson's STE, 16 per cent), to sell a controlling interest in their major subsidiary operations (LMT and STE) to Thomson-CSF. Thomson-CSF was the telecommunication arm of Thomson-Brandt, one of France's largest electronic groups whose sales in 1978 were $6 billion. This company and CIT-Alcatel, the telecom subsidiary of Cie Générale d'Électricité, another prominent French group, whose sales in 1978 were $8 billion, became the dominant suppliers to the Administration des postes et télécommunications (PTT). Thomson-CSF, who reportedly had no previous capability in telephone switching, supplied the Metaconta (ITT) and AXE (Ericsson) switches; CIT-Alcatel was engaged in the development of the E-10, an electronic digital switch. Thomson-CSF also embarked on digital switch development with the MT series.

In 1980 Thomson-CSF completed its takeover of the ITT and Ericsson subsidiaries. Recently Thomson-Brandt and Cie Générale d'Électricité have been nationalized. This is part of a government effort to bring its high technology industries to a leadership position.

ITT retained a switching subsidiary in France, but its share of domestic switching sales dropped significantly. In 1978 the message switching operation of CGCT was sold to Thomson-CSF. ITT's digital offering - System 12 - met with resistance in the French market, where the PTT split its orders between CIT-Alcatel and Thomson-CSF for digital equipment. Recently, the government nationalized the rest of ITT's telecommunication interests.

In 1980, France was reported to have set telecom export goals of 30 per cent of industry production by 1983 and 50 per cent by 1985. In 1979, approximately 19 per cent of the industry's turnover was exports. France is noted for aggressively subsidizing exports. In May 1982, a preliminary agreement between the government of India and CIT-Alcatel for digital systems and technology transfer reportedly included a commitment by the French government to cover half the value of the modernization project with export credits at an average 7.5 per cent interest rate.

There are various reports of government financial assistance to the electronics/data processing/computer industries. *The Wall Street Journal* puts the PTT's research budget at $136 million for 1982, up from $118 million for 1981. The *Electronic News* reported that the French telecommunication authority spent

$180 million on its R&D program in 1979. While the amount of state-funded R&D is not certain, the fact that it is extensive is not debated. The government has a telecommunication research laboratory, the Centre National d'Études des Télécommunications (CNET), which undertakes studies of future telecom technology and network requirements. It has, for example, been involved in studies of time division switching since the early 1960s. Other areas of activity include integrated circuits, optical fibre fabrication, and studies in optical switching.

c) West Germany (27 million telephones)

The Bundespost (BDP) is West Germany's telecommunication authority. The BDP favours domestic suppliers, several of whom may be approved to manufacture the same product. In the procurement of central office switches, contracts are allocated among several firms. Mr. T.P. Barnes, Senior Vice-President and Group Product Manager, Telecommunications Products and Systems Worldwide for ITT, stated that there is competitive bidding and a small percentage of the total contract is set aside to reward the low bidder. A quota allocation also exists for cable.

Siemens A.G., which is one of the five largest telecommunication equipment suppliers in the world, is based in Germany and is a major BDP supplier. Other important suppliers are Standard Electric Lorenz (SEL), an ITT subsidiary; Telefonban and Normalzet (T&N), an AEG Telefunken subsidiary; and Deutsche Telephone Und Kabel Werke (DTW). DTW is an affiliate of Siemens, which also owns part of T&N. There are several smaller companies, particularly in the apparatus field.

Siemens was the main manufacturer working on new versions of Germany's EWS analogue switches, when it was decided in 1979 to proceed with digital technology. Others in the EWS analogue group were SEL, T&N and DTW. Although there was some speculation that the BDP would choose a non-German digital system, Siemens, SEL, and Tekade, a German subsidiary of Philips of Holland, received orders for local switches for field trial purposes. While Tekade was an addition to the list of central office equipment suppliers, it had previously been active in Germany as a telecom supplier.

d) Sweden (7 million telephones)

Sweden, itself a small market by world standards, is the home base of LM Ericsson (LME), the specialized telecommunication equipment supplier. The Ericsson Group consists of the parent firm, Telefonaktiebolaget LM Ericsson, and subsidiary and associated companies with operations in over 100 countries. Only 16 per cent of its sales were in Sweden in 1976.

The Swedish telecommunication administration, Televerket, has a manufacturing arm, Tele, which supplies much of its equipment. Televerket is Ericsson's main competitor in Sweden for switching equipment and telephones. Televerket is licensed to manufacture Northern's SL-1 PBX.

LME's relationship to Televerket is highlighted in the anniversary publication, *LM Ericsson 100 Years*. Ericsson, as a domestic supplier, has participated in cooperative development projects with Televerket and has been assured a market for certain products. The following excerpt refers to transmission equipment:

> "Naturally, in relation to Televerket, LME has had the advantage of being a domestic enterprise. Detailed solutions have often been discussed with Televerket's engineers, who have thereby been able to see their ideas realized. The constant availability of experts, furthermore, puts the domestic enterprise in a favourable position.

> Most important for LME has been the decisive role played by Televerket in the development of new carrier systems. All systems for coaxial cables have first been installed in Sweden. . . . LME has been able to develop systems after a contract had already been concluded with Televerket. LME was thus assured of an outlet which warranted the development work, while Televerket obtained the systems it needed. In this way Televerket and LME specified the systems in cooperation." (Christian Jacobaeus, et al. *LM Ericsson 100 Years, Evolution of the Technology 1876-1976*, Volume III, (Sweden: 1977).

In 1970 Ericsson and Televerket formed a joint development company, Ellemtel, in which each had 50 per cent ownership. A principal reason for the formation of Ellemtel was to rationalize the telecommunication R&D effort and share the burden of the heavy research costs associated with advanced electronic products. After its formation, much of the R&D for the Ericsson-manufactured AXE system was done by Ellemtel. Like BNR, its work extends through the prototype stage of development. While Ellemtel serves as a focal point for the expertise of both Ericsson and Televerket, its role in avoiding costly duplication of effort is also stressed.

2. Japan (55 million telephones)

Nippon Telegraph and Telephone Public Corporation (NTT) is the major telecommunication administration in Japan. NTT has its own R&D labs, and works closely with selected suppliers. The four leading suppliers to the NTT are Hitachi, Nippon Electric Company, Fujitsu and Oki. Each of these companies is a member of a much larger company group, and each has operations which are multinational in scope.

Until 1981, Japan exemplified a closed, protected market. In December 1980, as a result of United States government pressure, Japan agreed to open up NTT procurement. A bilateral agreement with the United States provides for three separate categories or "tracks" for NTT procurement from non-Japanese firms. Items covered by Track I (specified non-electronic goods and standard telecom and electronic equipment) are included in the GATT Agreement on Government Procurement. Canada, along with other GATT nations, thus should have access to the estimated $1.5 billion of NTT procurement which falls in the Track I category. Under the bilateral agreement, the U.S. has the right to similar non-discriminatory treatment for the balance of NTT procurement (Tracks II and III), worth about $1.8 billion. Japan undertook to apply most-favoured-nation principles to all foreign firms. In this way, Canada and other GATT nations have, to a certain degree, been assured of like treatment for Track II and Track III items, although no contractual obligation exists between them and Japan. Track II covers advanced off-shelf equipment that might need modification to meet NTT requirements; Track III covers items that must be developed for, or with, NTT.

As is always the case, the application of such agreements is of more significance than the agreement itself. It is too soon to assess the results of this particular accord. Press reports place NTT estimates of purchases from foreign suppliers at approximately $24 million in the first 20 months. Outside suppliers often find that the amounts of individual contracts do not justify equipment modification and marketing costs. A key question is whether NTT will be open to the larger items that foreign companies want to sell. Several U.S. firms who are interested in supplying digital central office switches to NTT were reportedly told that NEC, Fujitsu, Hitachi, and Oki have just developed a switch in co-operation with NTT, and that digital PBXs and carrier systems might represent a better market in the near future.

3. United States (176 million telephones)

In the U.S., the AT&T operating companies account for approximately 80 per cent of the telephones. Its Long Lines provide the bulk of the long distance services. Most of AT&T's Bell System equipment requirements have been supplied by Western Electric, its manufacturing affiliate. AT&T and Western are co-owners of Bell Laboratories, a highly successful R&D establishment.

GTE, the largest independent carrier, accounts for another 10 per cent of the telephones. GTE is an integrated research, manufacturing and service entity. GTE relies on its manufacturing affiliates - Automatic Electric and Lenkurt - for much of its equipment, although not to the same extent as does AT&T. A 1981 U.S. House of Representatives report estimates that in 1980, 84 per cent of Bell System requirements were supplied by Western, while 59 per cent of GTE requirements were supplied by its manufacturing affiliates. The report notes that this is an understatement of GTE's reliance on its affiliates in certain equipment categories, since, for example, its wire and cable requirements are procured externally.*

The remaining 10 per cent of the U.S. market is open to outside suppliers. The two next largest independent telephone companies, after GTE, acquired manufacturing affiliates which they subsequently sold. GTE sells into this independent market and also sells abroad. Western for many years restricted its domestic sales effort to the Bell System operating companies. It has now announced that it has made arrangements to supply the independent telcos through distributors. The independent market, even without GTE and Long Lines, is reasonably large. Figures filed by Mr. Davies indicate that the total independent telco market in the U.S. in 1979, excluding GTE, was about as large as the total Canadian market ($1,935 million U.S. versus $2,137 million Canadian).

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* *Telecommunications in Transition: The Status of Competition in the Telecommunications Industry,* a Report by the Majority Staff of the Subcommittee on Telecommunications, Consumer Protection and Finance of the Committee on Energy and Commerce, U.S. House of Representatives (November 3, 1981).

As stated in Chapter II, various foreign-based firms are now active in the U.S. market. Concommitantly in 1977, AT&T, which withdrew from foreign competition early in this century, established a Bell System subsidiary responsible for overseas operations.

Regulatory decisions in the U.S. have ended the telco monopoly of terminal equipment and long distance services. Current developments in broad band transmission and cellular radio promise to erode gradually the monopoly provision of local loop services as well. This has had the effect of expanding the market possibilities for suppliers outside the vertically integrated structures. Western Electric, nonetheless, remains the dominant force in the United States. The House of Represenatives Subcommittee report referred to above indicates that Western's market share had not declined significantly in any of the network-equipment areas over the prior four years. Inroads had, however, been made in the terminal-apparatus market, where subscribers are free to own their equipment.

The vertical relationships have been challenged in regulatory and judicial proceedings in the U.S. Antitrust suits filed by private companies have, in some cases, been settled out of court by agreements to purchase a specified amount of equipment from outside suppliers. In 1975, an action brought by ITT against GTE resulted in a decision designed to prevent the preferential procurement of equipment by GTE's operating telcos from its affiliated manufacturing companies. The U.S. District Court's definition of non-affiliated manufacturers includes all U.S. manufacturers of telephone equipment in the application of the decision, with three exceptions. Companies domiciled or having their principal place of business outside the U.S., or directly or indirectly controlled by such companies, were not covered by the decision. Western Electric and companies whose telephone product has less than 80 per cent U.S. content were also not given access to the GTE market by this decision (United States District Court for the District of Hawaii, *International Telephone and Telegraph Corporation v. General Telephone & Electronics Corporation and Hawaiian Telephone Company,* Final Judgment, December 20, 1978).

Over the years, the federal regulator (Federal Communications Commission - FCC) has stressed the need for AT&T to examine general trade products more vigorously. In 1977 the company was ordered to submit a procurement plan that would require the Bell System operating companies (BOCs) to treat Western Electric and general trade suppliers at arm's length, but there were delays in establishing an effective mechanism for this. One suggestion rejected by the FCC was ITT's recommended quota plan for outside purchases, which the bureau staff reportedly felt would not guarantee better or cheaper service for ratepayers.

Most recently, and dramatically, the U.S. Justice Department settled a long-standing antitrust suit against AT&T, under terms which require AT&T to spin off the operating companies. AT&T is left with a largely unregulated business consisting of Western Electric, Bell Labs, long distance telephone service, and new telephone/computer/data services. The local companies will offer local service within exchange areas, exchange access services and the Yellow Pages. The BOCs will be able to supply terminals, although AT&T retains ownership of its installed terminal base and the ownership and control of its telephone stores.

The impact of non-integrated Bell operating companies on the equipment market is related to the assets and service they will control. By AT&T's estimates, implementation of the Justice pact will involve the assignment of two thirds of Bell's assets to the local Bell companies. *The Wall Street Journal* reports that of the 8,000 Bell switching offices nationwide, roughly 7,200 are not used for long distance calls, and will go automatically to the local BOCs. The dominant user will become the owner of the remaining switching offices. Bell's operating telcos, however, are likely to retain close links to Western Electric, since the installed base, which is a critical factor in areas such as switching, consists overwhelmingly of Western equipment. The existing Long Lines structure remains.

Interest in access to foreign markets on a reciprocal basis is becoming more apparent among U.S. lawmakers, as a more open environment is emerging in that country. When, in 1981, a fibre optic bid for the lightwave link between Cambridge, Massachusetts, and New York resulted in a rumoured contract award to Fujitsu Ltd. of Japan, the low bidder, negative Congressional reaction ensued. AT&T subsequently awarded the contract to Western, a move which was authorized by the FCC, who had originally ordered AT&T to entertain bids from outside suppliers. The fairness of the Fujitsu bid, the importance to the nation of developing fibre optic technology and national security concerns were all cited as reasons for reconsidering. In a July 1982 request for proposals for fibre optic systems, AT&T stipulated domestic manufacture of the critical optical components and final assembly in the U.S. of major electronic components and cable.

CHAPTER VII

EVIDENCE OF SUPPLIERS

As stated in the Introduction, much of the evidence tendered before the Commission was to the effect that the Bell market was closed to Northern's competitors. The buyer-seller relationship between Bell and Northern has been fully discussed in Chapter III, along with other aspects of vertical integration. The vertical relationship between B.C. Tel and its affiliated suppliers has been discussed in Chapter IV. The evidence covered in this chapter is of two types. The first relates to the testimony of suppliers who were of the view that the price or quality of their equipment was more advantageous to Bell or to other buyers than that offered by Northern. Most of this evidence dealt with subscriber apparatus and has already been discussed in Part I. The central issue in the subscriber equipment area is not vertical integration but monopoly supply by telcos. A number of recommendations were made in Part I which were designed to provide subscribers with the wide choice available in a free, unregulated market.

Also presented is the evidence of representatives of Mitel and Plessey, who discussed Bell's treatment of them in areas besides that of equipment purchase. This material is not necessarily related to the issue of vertical integration, but it is included because it indicates an attitude towards non-affiliated suppliers which contradicts Bell's stated concern for fostering a Canadian telecommunication industry.

There is little evidence that Northern or Automatic and Lenkurt are perceived by competing suppliers as lacking in competitive performance with respect to the equipment purchased by Bell and B.C. Tel. This is a source of assurance in the performance of these suppliers, or in the purchasing practices of the telcos. However, it is important to note that this test of the operation of vertical integration is not an onerous one. Northern and Automatic and Lenkurt have few competitors in most equipment lines. Moreover, outside of central office switches and subscriber apparatus, Automatic is primarily a distributor; most suppliers of other types of equipment have at least indirect access to B.C. Tel. Northern, a broad-line supplier, has the advantage of economies of scale in many equipment lines in comparison with its competitors. Also, the requirement that suppliers had to consider their offerings to be superior, rather than just equal, is a difficult one to meet. In spite of the foregoing considerations, given the evidence in the inquiry the test is the most appropriate one available for evaluating the operation of vertical integration in the existing environment; in the case of subscriber terminal equipment, the test produced fairly conclusive results.

1. Telephone Repair

It was stated by Mr. H.W. Jamieson, Marketing Manager of Palco Electronic Manufacturing and Supplies Ltd., a firm which supplies telephone repair and overhaul services in Alberta, that Northern's bid to AGT in 1974 was substantially lower than the price Northern charged to Bell for the same service. Information obtained by the Commission from Northern shows that Northern's quote to AGT was not below the price charged to Bell, and that the price to Bell had been in existence since July 1973. This last point is of some significance in a complaint of this kind, given the clause in the supply agreement that requires that Bell receive as low a price as provided by Northern to other customers under similar circumstances. If Northern is seeking to expand its sales, it may reduce the price quoted to other telcos and to Bell. Under such circumstances, the price previously paid by Bell could have been higher than that paid by other telcos to competitors of Northern.

Ordinarily one would not expect anyone outside the Bell-Northern group concerned with the transaction in question to have reliable price information. This was the case in the complaint made on behalf of Palco. However, information in an industry often travels in mysterious ways; other complainants, representing Vidar, (A Division of TRW Inc.) and Transcom Electronics Manufacturing Limited, had much more accurate, though not perfect, information on Northern's prices to Bell. These complaints are discussed in a later section.

2. Loading Coils and Key Telephone Line Cards

The testimony of Mr. S.L. Wilson, President, Quality Communication Products Ltd., concerned telephone loading coils and key telephone cards. Quality Communication Products Ltd. was established in 1963 and manufactures a variety of low per-unit cost telecom products using imported components. Its sales in 1976 totalled $2.1 million, with coils accounting for approximately $1.8 million. The company's plants were located in Morden, Manitoba and Walhalla, North Dakota. The latter plant was described as being basically a warehouse; its products are 80 to 100 per cent completed in Morden.

Mr. Wilson testified that Northern's quotes for loading coils and key telephone line cards to 'edmonton telephones' were higher than the prices charged by Quality for equivalent items. In the case of loading coils, which are used to prevent distortion on cables transmitting voice traffic, Mr. Wilson stated that Northern's tenders to 'edmonton telephones' were in the $4 range, while Quality was charging $3.25 f.o.b. destination.

Mr. Wilson estimated that the market for loading coils in the Prairies was a little under $2 million and was divided between his company and Superior Continental. Quality also sold loading coils in the Maritimes, as did Superior. Northern also had "some" of this market. Mr. Wilson indicated that his company had unsuccessfully tried to sell loading coils to Bell Canada, who "buy a few beyond the Northern". They had written to Bell four years earlier and since then had called on a number of people at Bell.

In the case of key telephone line cards, which control the operation of key telephones, Mr. Wilson stated that the price of a particular card from Quality, ITT, or Cook was in the $21 to $22 range, whereas Northern was quoting $38 to 'edmonton telephones'. The Prairie market for key telephone line cards was put at 45,000 to 50,000 units. Quality was selling cards to MTS and AGT. Sask Tel was evaluating their cards.

Mr. John Rudnick, President of Cook Electric Company of Canada Limited, also testified on Northern's prices for line cards. Cook Electric of Canada, a wholly owned subsidiary of Cook Electric, U.S., was acquired by Northern in December 1976. Mr. Rudnick testified that in a quote to AGT for 16,000 cards, where Quality, ITT, Cook and Northern bid, the prices were of the order of $20 to $21 for Quality, $22 for ITT, $23 for Cook, and $28 to $30, he believed, for Northern. While this price difference between Northern and other suppliers was not as high as that noted by Mr. Wilson, it is nonetheless substantial.

3. Digital Multiplex Equipment

Considerable insight into the dynamics of equipment selection by Bell is provided by the evidence submitted in relation to digital multiplex equipment. The evidence is contained in the testimony and supporting documentation of Mr. E. Keane, Vice-President and General Manager, Vidar (A Division of TRW Inc.), and Mr. D.F. Hudson, Chief Engineer of the Montreal Area, Bell, 1972-75. Mr. Hudson joined Northern Telecom in 1977 and at the time of his testimony was Vice-President, Subscriber Switching, Northern Telecom Industries, Inc. Vidar was a new entrant in Canada. It had set up an assembly operation in Alberta, which it subsequently closed when it lost the AGT business to Northern in 1978. Other evidence that is of importance is a successful bid by Northern on digital multiplex equipment to AGT in 1978.

Multiplexing is a technique for concentrating telecommunication signals in order to take advantage of the physical capacity of transmission mediums. There are two types of components associated with multiplex equipment - a fixed component that provides common equipment for a certain number of trunks, and components that stand in a one-to-one relationship with the number of trunks.

Whether multiplexing is introduced on a particular trunk depends on the distance between the switches and the volume of traffic. Both considerations come down to a comparison of the cost of cable and associated equipment, such as repeaters and loading coils, with that of all the equipment required in multiplexing.

The major application of digital multiplex was in the high-density traffic areas in and around Montreal and Toronto, where there are numerous switches which are joined directly, or indirectly, through tandem switches. The result is a complex web of trunk lines, many of which were candidates for digital multiplex. A major cause of growth in both areas was the expansion of Extended Area Service. Particularly high growth was projected in internal Bell Group studies for the 1975-77 period for the Toronto area, with the number of systems at the end of the three years expected to be more than double the number of systems in existence at the end of 1974.

The first generation of digital multiplex equipment installed by Bell was produced by Northern under licence from Western. This equipment, the D-1, was followed by the DE-2, a Northern-designed system that was first supplied for widescale application in 1972. In contrast to Western Electric's D-2, which was designed for application in long distance toll traffic, Northern's DE-2 was designed for local as well as long distance applications. Not long after Bell standardized on the DE-2, a new generation of equipment was introduced in the United States. As in other areas of telecommunication equipment, each generation rode the slide of reduced size and cost accompanying advances in electronic technology. Northern's production of its DE-3, which commenced with limited volumes in the fourth quarter of 1976, awaited the development of its production capability in thick film hybrids.

Bell's study for possible application of the third generation multiplex digital system (known as D-3) apparently started some time in 1974, judging from the fact that a BNR study was submitted to Bell on January 3, 1975. The exact time frame during which this system would have been available to Bell was a point that was explored with Mr. Hudson. He was of the view that the D-3 may have been available from a number of suppliers in the U.S. in 1974, but that there were probably compatibility problems that had to be solved. This argument was not supported by the evidence. The digital multiplex technology was developed and introduced by Western Electric. Since suppliers generally hope to sell to AT&T operating companies, it is highly unlikely that manufacturers would produce equipment which was incompatible with equipment that would be widely used by the AT&T operating companies. In the case of Vidar, their D-3 was being produced under a patent cross-licensing agreement with Western Electric, and it is difficult to believe that they would not ensure that their equipment was compatible with that of Western Electric.

According to Mr. Hudson, the Vidar D-3 became commercially available in 1974. The D-3 was evaluated by BNR in 1974 and by Bell in 1975. He estimated that the field trial occurred in March 1975. He also said that ITT equipment first became available in the U.S. in 1973, and was evaluated by BNR in 1973 or 1974. Other suppliers who had a product at about the same time were General Electric and Lynch Communication Systems Inc., but the former abandoned the business. It is known that Lynch, like Vidar, depended on patent licensing from Western, and it is likely that the other suppliers were also so dependent. It would also explain why they were able to follow Western Electric so quickly.

The evidence on digital multiplex centered on the price comparisons between Northern's DE-2 and Vidar's D-3. There is no question that the D-3 was cheaper per channel than the DE-2. However, whether it would have been to Bell's benefit to purchase the D-3, rather than retaining the DE-2, was considerably affected by the cost of standardizing on the D-3, given that Bell expected availability of Northern's DE-3 in a relatively short time, on acceptable price terms. The benefit of adopting the D-3 in favour of the DE-2 would have approximately doubled if Bell had placed itself in the position to adopt the D-3 in 1975 rather than in 1976, while the cost of standardization would have been the same.

Price comparisons between Northern's DE-2 and Vidar's D-3 are complicated by the fact that the capacity of their common equipment is different. There are two levels of common equipment in the DE-2. One level of common equipment has a capacity for 96 channels.* A second level, used in conjunction with the first, has a capacity for 24 channels. The initial installation of the DE-2 entails both levels of equipment, with channel ends being plugged in as required. The common equipment of the D-3, in contrast, only has one level of common equipment, with a capacity for 24 channel ends.

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* Although common equipment for 96 channels is referred to, there are 192-channel bays which are destined for very large offices.

Table 27, which assumes different levels of capacity utilization, is a modification of the price comparisons made by Mr. Hudson in his evidence. All his comparisons were based on the assumption that the common equipment for 96 channels would be fully utilized. As will be discussed below, the same approach was taken in the internal studies of the Bell Group which were filed with the Commission. This approach is deficient, because even in high-density applications some time is required before full utilization of the common equipment is achieved. The time that it takes for full utilization to occur must be taken into account along with the cost of funds. This was recognized in the BNR Study of January 3, 1975, through an assessment of the rate of growth of traffic, in the related context of deciding whether to replace analogue trunk lines with digital multiplex. In making price comparisons only for the full capacity utilization case, the very high front-end costs of the DE-2, which is its major disadvantage, are masked. Excluding the costs of installation, the cost of common equipment in the DE-2 for 96 channels was of the same order of magnitude as a fully equipped 24-channel D-3: that is, the costs of the 24-channel common equipment plus the plug-ins for 24 channels. Thus, as is clear from the comparisons in Table 27, the DE-2 was far more costly than the D-3 in situations where close to full capacity utilization of the common equipment did not occur within a short time after it was installed. Moreover, the cost to Bell would be greater than indicated by examining the purchases of DE-2 equipment and estimating an average cost differential for that volume of purchases. It must be assumed that there would be situations where the low volume of traffic, along with other variables such as length of trunk lines and anticipated growth, made the DE-2 too expensive and resulted in a continuation of analogue techniques. Any situations in which digital multiplex was not utilized because the DE-2 was not cost effective, where the D-3 would have been, represented an additional cost to Bell.

TABLE 27

THE PRICE OF NORTHERN'S DE-2 PER CHANNEL END RELATIVE TO VIDAR'S D-3 (D-3 = 100)*

	July 8, 1975	March 2, 1976**	May 28, 1976
24 channels	180	130	170
48 channels	140	110	140
72 channels	130	100	130
96 channels	120	100	130

SOURCE: Information filed with the Commission showing Northern's and Vidar's prices to Bell.

* Rounded to the closest tens digit. The column headings refer to the dates of the Northern price quotes. The corresponding dates for the Vidar equipment are: August 13, 1975, December 12, 1975, October 1, 1976.

** As noted in the text significant reductions in the price of Northern's common equipment occurred on October 1, 1975 and March 2, 1976.

The only information on installation costs is available from the BNR Study of January 3, 1975. Based on the figures available to the author of this study, the installed cost of the DE-2 per channel end was considerably more than the cost projected by Northern at that time for the installation costs per channel end of the DE-3. Taking the projected installation cost per channel end of the DE-3 as 100, the comparable cost of installation per channel end of the DE-2 is between 156 and 220.* Allowing for the fact that installation costs are primarily (and perhaps exclusively) front-end costs, the difference in installation costs per channel would vary inversely with the number of channels. The indication is that the cost differences in Table 27 for equipment understate the total cost difference to Bell at all levels of capacity utilization, but particularly so at the lower levels.

The BNR Study stated that the initial average "fill" in a digital multiplex group was 10 channels. However, as far as can be determined, the cost comparisons between the DE-2 and the D-3 were based on the assumption of complete utilization of all common equipment. In encouraging further exploration of the purchasing of D-3 equipment until Northern's DE-3 was available, the author pointed to savings in capital costs of the order of one-quarter million dollars that the D-3 offered over the DE-2. This conclusion appears to be based on the procedure of arriving at a per-channel cost when all common equipment is fully utilized and then multiplying this figure by the number of channels assumed for the initial installation. However, based on an initial "fill" of 10 channels, as assumed in the BNR Study, there would be a difference in capital outlay for equipment between the DE-2 and the D-3 of close to $3 million.

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* Only a single figure is presented with regard to installed cost per channel end, but the equipment cost per channel end varies with the types of channel units that are installed, which depend on the particular type of trunk line. There are three different equipment costs per channel end (excluding installation) that are referred to in the BNR Study. When these costs are subtracted from the single installed cost per channel end, a range is obtained for the cost of installation per channel end.

Installation costs would add to this figure. At an assumed cost of capital of 10 per cent, it is easy to see how the effect of ignoring the cost of carrying the under-utilized common equipment in the DE-2 can easily swamp the cost differences between the DE-2 and the D-3 when full capacity utilization is assured.

In order to gain some appreciation of whether the common equipment capacity was quickly utilized, the Commission obtained from Northern its volume of sales of DE-2 equipment in the years 1978 through 1980. Given that the DE-3 was available by late 1976, it is reasonable to conclude that no new installations of 96-channel common equipment for the DE-2 were made in 1977. Also, given that the busy season occurs at the beginning of the calendar year, much of the common equipment would have had to be installed early in 1976. By 1978 there was, thus, a good part of 1976 and all of 1977 available for the addition of the 24-channel common equipment and plug-ins for individual channels. Yet Bell purchased almost one million dollars' worth of DE-2 equipment in each of the three years 1978-1980. What is interesting about the figures is that there is no discernible downward trend - purchases in the three years are almost constant, although there may have been an increase in prices and hence a decline in real purchases. What is not known are the purchases of DE-2 equipment in 1981 and the capacity now remaining in DE-2 bays. This information would be necessary to obtain an approximation of the overall cost difference between the DE-2 and the D-3 to Bell. What is clear, nevertheless, is that any internal Bell studies or directives that compared the cost of the DE-2 and D-3 based on full capacity utilization of the DE-2 common equipment were not addressing the cost comparison question correctly.

All of the internal Bell studies submitted by Mr. Hudson justifying the continued purchase of the DE-2 assume full capacity utilization of common equipment. Based on Mr. Hudson's oral evidence and the BNR Study of 1975, it was clearly understood by Bell that the rate of growth of traffic was a critical variable, since it determined how quickly the capacity of the common equipment was used.

A vivid illustration of the difficulties created by the large capacity of the DE-2 common equipment is provided by circumstances which required Bell to buy the D-3 from Vidar. The purchase was made because there was an unanticipated demand for digital multiplex equipment which Northern was unable to meet because of insufficient lead time. The demand for the Vidar equipment was occasioned when Simpsons in Montreal moved their mail order bureau from downtown to an industrial park. This resulted in a fairly heavy demand for additional transmission capacity in the vicinity of the industrial park. The equipment was used with copper pairs in the cable, thus freeing capacity for the order bureau. The following evidence was provided by Mr. Hudson in discussing the purchase of the Vidar equipment:

> "Q. If I understand the demand requirement in this particular application, if DE-2 had been available you could have satisfied your need by just buying one of these machines instead of buying five of these Vidar machines?
>
> A. It is very difficult to conclude that, because we probably relieved facilities on multi-routes and if I did that with DE-2 I might have to take five DE-2 systems to do it. DE-2 comes in bigger chunks, so ---
>
> Q. How many channels did you need here?
>
> A. We purchased 75 channels.
>
> Q. And DE-2 is what, 96?
>
> A. Ninety-six, but the point is we may not have granted the relief only on one route, we may have relieved it on several routes."

Northern changed the price of DE-2 equipment on three occasions in 1975 and 1976. The changes taking effect on October 1, 1975 and March 2, 1976 were reductions in the prices of common equipment for 96 channels; initially five per cent and 30-35 per cent subsequently. Although Mr. Hudson stated that he did not believe that these reductions were in response to Vidar's attempt to penetrate the Bell market, the timing and wording of Northern's correspondence with Bell indicate that the price reductions were a marketing response on Northern's part, rather than a reduction made possible by reduced cost. The price reductions on the 96-channel common equipment come through as a marketing ploy designed to retain Bell as a customer for carrier equipment until the DE-3 could be made available. The increase taking effect at the end of May 1976 of nine per cent covered several lines of equipment. In the case of the DE-2, the equipment affected was the plug-ins for individual channels.

The Vidar prices on which Table 27 is based are unsolicited submissions to Bell, except for the column labelled March 2, 1976, where actual invoice prices were used. However, none of Vidar's prices can necessarily be taken to represent the lowest prices that Bell could have obtained from Vidar. In the case where actual invoice prices were available, Bell had purchased a small number of units from Vidar because of an unforeseen demand which could not be met by the DE-2. This was not a circumstance which would cause Vidar to sharpen its pencil. Vidar's last offer to Bell, which shows up in the comparisons of March 2, 1976 and May 28, 1976, conveys the impression that a considerable effort was being made to provide Bell with a sufficiently attractive price so that it would enlist Vidar as a major supplier of digital multiplex equipment. Even in this instance, however, it is not certain that Bell could not have obtained lower prices. Only active price negotiations and a commitment by Bell to Vidar that it stood ready to make volume purchases under the proper price terms would have revealed Vidar's best price to Bell. This conclusion also applies to any price comparisons between Vidar's D-3 and Northern's DE-3.

A point that has emerged again and again in the inquiry, and one particularly stressed by Northern, is that a high technology industry such as telecommunication equipment results in leap-frogging of a successful firm's products. A position of technological lead may be overcome, and perhaps reversed, as other firms take advantage of the extra time which they have taken to introduce their product to incorporate state-of-the-art procedures and components, allowing them to introduce new features and to reduce prices. With the next generation of equipment, the position of the initial leader may be regained for the same reason that it was lost. In short, it is an unworkable strategy to try to be first all of the time. Sufficient sales and time must be allowed to recover design and development costs before a new generation of equipment is introduced. While this is an accurate representation in outline, it should be recognized that design and development costs on a generation of equipment do not follow a pattern of a large lump of expenditure and then a rapid fall-off as expenditures are reallocated to a new generation of equipment. Within the limits of the basic design of the product, expenditures on design and development, to reduce costs and enhance the product features, may continue throughout the life of the product.

According to Mr. Keane, when Vidar introduced its version of the D-1 in 1965, two years after Western Electric, it incorporated more advanced electronics than Western Electric's version and was much more compact. When Western brought out a second generation - the D-2, which was used only in toll applications - Vidar did not follow. Given the overwhelming position of AT&T in Long Lines, Vidar and other manufacturers probably saw no point in introducing a product that would have so little application in the independent telco market in the U.S. Northern, however, introduced its own version in 1972 of the DE-2, which was designed for use in a variety of trunk lines. The date of the introduction of Western's D-3 is not known, but it undoubtedly was before 1973, when Vidar made its first sales. Northern's DE-3 was introduced in 1976 and was available for major installations in time for Bell's busy season at the beginning of 1977. Based on sales to telcos other than Bell, the DE-3, and the DE-4 introduced in 1978, are successful products. In 1979, the year for which a product breakdown of export sales was provided, sales in the U.S. for the DE-3/4 exceeded those in Canada. Northern also succeeded in winning a major tender in 1978 for AGT's 1979 equipment needs. Unlike the marketing of its leading switching equipment, such as the SP-1, the DMS family, the SG-1 and the SL-1, pricing of the DE-3/4 appears to be more critical to its success. In a comparison of prices charged by Northern for a number of products to Bell and customers in the U.S. as of July 1979, the level of prices on most products was lower to Bell.* This was not the case for the DE-3/4, for which the relative price to Bell was close to the highest, being exceeded only by some terminal products for which styling rather than technological characteristics are most important.

At the request of the Commission, Northern submitted a copy of its bid to AGT for digital multiplex equipment with delivery starting in February 1979. Northern also prepared a brief document explaining aspects of its bid and included a comparison of the prices submitted to AGT with those charged to Bell prior to the bid to AGT and for 1979. The prices Northern quoted to Bell in 1976, which would have applied to purchases in 1977, were largely unchanged in 1978, with the exception of a reduction of eight per cent on two types of channel units and a reduction of 13 per cent on common equipment, excluding the bay. Northern's prices in its bid to AGT were well below those that it had been charging Bell in 1978, with a difference of 18 per cent on four units of equipment and from 24 to 29 per cent on seven other units. The prices to AGT were reflected in those paid by Bell in 1979, in accordance with their supply agreement.

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* The price comparisons were prepared by Northern and presented as price indices, with the Bell price set at 100.

It is not known whether the sharp price reduction from 1978 to 1979 reflected economies of manufacture. The fact that prices in the U.S. were below those being paid by Bell in 1979, in contrast with other products, strongly suggests that the bid to AGT reflected prevailing market prices. It is an open question whether prices to Bell would have been reduced in the absence of the bid to AGT.

4. Digital Repeaters

Mr. R.S. Bessette, President of Transcom Electronics Manufacturing Limited, gave evidence concerning the efforts of his company to sell a number of products to Bell. Transcom was formed in 1964 and until 1969, when it began assembly operations in Saint-Jérôme, Quebec, it served solely as a distributor. The parent company, Transcom Electronics Incorporated, Newport, Rhode Island, was purchased by Lynch Communication Systems Inc., Reno, Nevada, in 1971. The products carried by Transcom in Canada are voice frequency products, which are in the product line of Transcom in the U.S., and carrier equipment produced by Lynch. Transcom had 35 employees in 1978 and expected to have sales in that year of $1.4 million. Sales in 1976 and 1977 were $1.7 million and $1.4 million, respectively. According to the annual report of Transcom filed with the Commission, Transcom had a profit after taxes of $45,488 in 1977, following profits of $304,116 in 1976. The level of capacity utilization in 1977 of the Canadian plant, reported by its parent to the Securities and Exchange Commission (Form 10-K), was approximately 50 per cent.

Sales of the parent company in 1977 were slightly over $25 million U.S., with about 61 per cent derived from the sales of carrier equipment and related products. Apart from Western Electric, the company's largest competitors in the U.S. are, as stated in its 10-K, Lenkurt Electric, ITT Corporation, the Vicom subsidiary of TRW, and Wescom. A point of some importance is that in 1968 the company obtained a patent licensing agreement with Western Electric. The company notes that this agreement has been of substantial benefit in reducing the cost of engineering its systems and products. The company spent $824,000 in 1977 for this purpose; this was slightly more than three per cent of sales. This is below the general average of telecommunication equipment manufacturers, but it might be closer to the level of other suppliers developing products similar to those of Lynch.

The thrust of Mr. Bessette's evidence is that Transcom has available a number of products which are less expensive than those bought by Bell from Northern, and that, except in unusual circumstances, Bell has not taken advantage of what Transcom has to offer. Bell entered written rebuttal evidence from Mr. R.E. Hill, Director, Transmission Systems Development, Bell Canada. His statement was transmitted by letter of April 16, 1981, at the time when Bell called its last witnesses. These facts are set out because Mr. Hill was not called and the Commission must now decide what weight to attach to assertions made by Mr. Bessette, which were not addressed in Mr. Hill's statement. These assertions concern prices paid by Bell to Northern for products similar to those available from Transcom. Mr. Hill's statement contained information on price changes in the case of digital repeaters. These prices corresponded closely to those that Transcom's salesmen had reported to Mr. Bessette, a fact which lends weight to his evidence. Mr. Hill's statement did not deal with that part of Mr. Bessette's evidence concerning price comparisons for other products. It would have been a simple matter to contradict this evidence, if it were incorrect. The thrust of Mr. Hill's evidence is that Transcom's products were not serious candidates for adoption by Bell, because of the respective features of the Northern and Transcom products.

Bell standardized on its LD-1 carrier system in 1973. The system had been developed by Northern in co-operation with Bell and BNR. As described in Northern's 1977 Product Handbook, it

> ". . . consists essentially of terminal and line repeaters with standard twisted paired cables as transmission medium, operating at 1.544 Mb/s. Capable of transmitting 24 telephone channels (such as outputs from DE-2 and DE-3 Channel Bank), over two pairs of cables for distance up to 200 miles. Line repeaters [are] required about every mile, powered from central office."

The piece of equipment about which Mr. Bessette gave evidence is the line repeater mentioned above.

Other producers of digital repeaters referred to by Mr. Bessette were Stromberg-Carlson/Vidar, ITT and Western Electric/Lenkurt (with the slashes representing interchangeable products). The Transcom product, the "Mini-T", was smaller than other units on the market. One of the advantages claimed for it was that it used less power and thus there could be a larger number of repeaters on the line with a given amount of power than was the case with competing products. The Mini-T was introduced in September 1976.

Transcom won a competitive bid from AGT for 2,000 units which led it to start assembly of the product in Canada. Earlier, Canadian assembly was restricted to the voice frequency products of Transcom. Forty units were sold to Bell for evaluation in August 1977. According to Mr. Hill's statement, in September five of the units purchased "were found to be defective on pre-installation testing." After the units were installed on a field trial route in November, it was discovered that the fault locate feature of the Mini-T was incompatible with the LD-1 system. Following telephone discussions with Lynch, the original 40 units were replaced with modified units in March 1978. These units were submitted to BNR for evaluation and four units were found to be defective by BNR. In the words of Mr. Hill:

> "This failure rate was high and unacceptable by Bell standards. In June, 1978 the Lynch repeaters were returned to Bell by BNR and installed on the Brampton-Malton portion of the Field Trial route."

The field trial ended in October 1978. The results of the field trial and lab testing were submitted in confidence to the Commission as appendices to Mr. Hill's statement. The lab evaluation report is dated June 1978 and that of the field trial, which also includes an overall summary, is dated May 1979, seven months after the trial was concluded and almost two years after the initial 40 units were sold to Bell.

According to Mr. Hill's statement, the Mini-T units were purchased for evaluation because:

> "Bell wished to assure itself that the LD-1 repeaters it was purchasing from Northern represented the best combination of price and performance. A 'paper review' of the brochures from various suppliers indicated that the Lynch Mini-T, which Transcom distributed, was worthy of further investigation because, unlike some other manufacturers' repeaters, it was compatible with the LD-1 repeater cases Bell was using."

Smaller suppliers such as Lynch are required to develop products which are physically compatible with those of larger suppliers. Transcom provides different casings for a number of products, which are compatible with shelves or casings of firms such as ITT and Western Electric.

No explanation is provided in Mr. Hill's statement as to why Bell decided to compare Northern's product with those available from other suppliers. The timing of the review suggests a similar situation to that in digital multiplex, discussed earlier. Northern's system was standardized by Bell in 1973. It appears to have been overtaken by its competitors at some point after it was introduced. This is suggested by the pricing information in Mr. Bessette's evidence and in the price announcements sent by Northern to Bell. By letter dated April 1, 1977, Transcom first submitted an unsolicited quote to Bell which was well below Northern's price to Bell. A price of $165 per unit was specified for quantities below 1,000 units, and $140 per unit for quantities in excess of 1,000 units. Northern's price to Bell for a comparable unit, after applying the usual discount, was $202.01. On a similar type of unit, Northern's price to Bell was $176.18, and Transcom's quote for a comparable unit was $149 for quantities under 1,000 and $125 for quantities over 1,000. It was further stated that for quantities well in excess of 1,000 units Transcom would like the opportunity to submit separate quotes, which implied that lower prices were available on very large orders. Mr. Bessette stated, when discussing market size, that Transcom's winning bid to AGT had been for 2,000 units and that Bell's annual requirements were around 25,000 units.

Mr. Bessette was asked whether costs per unit would fall dramatically as the level of output increased from 2,000 to 10,000 units. He replied that costs would not fall "dramatically" over that range of output, as was stated to occur between 100 and 2,000 units.

On May 17, 1977, Northern sent a letter to Bell announcing a price reduction effective October 1, 1977. The new price was close to that which Transcom had quoted to Bell for small quantities. The letter from Northern explained that the reason for the price reduction was a redesign of the repeater which permitted it to be produced at a lower cost, but that the new price would apply regardless of whether the older model or the redesigned unit was shipped. It was also stated that the change in design had resulted in a product with improved performance. Transcom then sent Bell a second unsolicited quote, dated June 21, 1977, which stated that the Mini-T was now being assembled in Canada and that this permitted Transcom to reduce its price. The new price of $110 applied to any quantity and represented a sharp reduction from the earlier Transcom quote. Transcom had submitted a quote to AGT at about the same time for $98 per unit.

A second price announcement by Northern was sent to Bell on July 21, 1977, which stated that a further price reduction would be effective on the same date as in the earlier announcement, October 1, 1977, and that a further reduction could be anticipated by April 1, 1978. The reasons given for the reductions were "a recent restructuring" of Northern's manufacturing plans "and a recast view of the volume requirements" for the latter half of 1977 and the first half of 1978. The projected price for April 1978 was still above Transcom's second quote.

The strong impression left by the chronology and level of price quotations is that both Transcom and Northern were responding to what they perceived to be prevailing prices. It is doubtful that the savings from assembly in Canada would have justified the sharp drop between Transcom's first and second quotations. Transcom's first quote to Bell was well below what Bell was paying Northern, and the price difference appears to have been considered sufficient to cause Bell to consider the Transcom unit, if only as a second source. The first Northern notification of a price change was undoubtedly, as stated by Northern, made possible by a change in the design of the unit. Without the price reduction Northern would have been out of the running as a competitive supplier of digital repeaters. The second quote of Transcom and the second price notification sent by Northern would appear, even more clearly than the first communication, to have been competitive responses.

The question that the evidence leaves unanswered is what Bell considers to be an acceptable price difference between the price it pays Northern and the prices at which an equivalent product can be obtained from other suppliers. The Commission is in no position to evaluate the technical information provided by Bell, nor does it know whether the problems that most bothered Bell were correctable by Lynch, and at what cost. However, the evidence is unmistakable with regard to the very large differences in outlay between buying the repeaters sold by Transcom and those supplied by Northern. The suggestion that Transcom was perhaps engaging in penetration pricing in its quote to AGT was disputed by Mr. Bessette. It must be assumed that the bid to AGT was influenced by Transcom's reading of what other suppliers besides Northern might bid.

5. Voice Frequency Products

Mr. Bessette's evidence also dealt with voice frequency equipment. Voice frequency or line-conditioning equipment

> "performs a wide variety of functions at voice frequencies mainly associated with the interconnection/interfacing of the various equipment throughout the telephone system . . .
>
> Generally it consists of many different types of plug-in units, used, for example, to match signal levels, compensate for losses, signal, change 4-wire to 2-wire circuits, terminate connections, attenuate, amplify, suppress echoes, etc."

a) Repeaters

One of the more important voice frequency products is the repeater. Western introduced a repeater designated the E-6 in the 1950s. Other suppliers followed with "physically equivalent" products. Bell standardized Northern's E-6, which it purchased in the 1960s and early 1970s. Transcom's version of this product was the TE-6.

The repeater is one of a number of voice frequency products located in central offices or at intermediate points. Until Bell-BNR-Northern developed a universal voice frequency equipment system between 1971 and 1973, each of the items of voice frequency equipment in Bell central offices had its own bay and shelf arrangement, which necessitated inter-bay cabling. Plug-ins for the system were developed "primarily through 1975, and [development] still continues." The system, which is referred to as the VF-300, is seen by Bell as providing a number of important advantages over the earlier arrangement of separate bays and shelves. Other suppliers, such as Wescom, also have such systems. Transcom offers a mounting equivalent to Northern's VF-300, and separate equipment items, such as the TE-6, whose housing has been modified to fit it. Other active suppliers of voice frequency repeaters are Lorain, Lear Seigler and Wescom.

In 1973, Northern introduced a new amplifier, the QVF-9, designed for the VF-300 mounting. According to Mr. Hill's statement it was an advance over the E-6 "because it could be used on loaded[*] or non-loaded cable circuits with less supplementary equipment and fewer adjustments." The E-6 was also purchased by Bell between 1973 and 1976 to utilize already installed shelf capacity. Transcom introduced new housing for its TE-6 that could be used with VF-300 mounting. One unit, the TE-6/QVF, was for applications when there was loading, and another, the NLC/QVF, was for non-loaded applications. Both units were purchased by Bell in 1976 when it could not obtain a sufficient number from Northern. Also, between 1974 and 1976, Bell purchased E-6-type amplifiers from Transcom and others because Northern could not meet Bell's volume requirements.

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[*]Loading coils are used on cables transmitting voice traffic to prevent the distortion of voice messages. They can, however, cause problems on cables dedicated to data traffic and must be removed.

Mr. Hill's statement on the TE-6/QVF follows:

> "The TE6 QVF was introduced by Transcom in 1976. This equipment was simply the TE6 repackaged to fit into the Northern VF300 universal shelf. Bell purchased a number of TE6 QVF in 1976 when it was unable to obtain a sufficient number of QVF 9's from Northern to meet all service commitments. The TE6 QVF could only be used for our needs on loaded cable. The NLC QVF was bought from Transcom for use with non-loaded cable. Purchase of the TE6 QVF and the NLC QVF was never considered on a continuing basis. They were earlier versions of technology which lacked the more universal application available with the QVF 9."

It is not clear what is meant by the last sentence. According to information received from Northern, subsequent to the tendering of Mr. Hill's evidence, there are two separate Northern repeater units: the QVF-9A, without a disabler feature, and the QVF-9B, with a disabler unit. "The function of the disabler unit is to reduce the gain on idle circuits in order to prevent 'singing' on the line. In effect, the disabler feature will turn off the repeater when the circuit is idle. This is used mostly on toll lines and high gain lines." Given the foregoing, it is the Commission's understanding that the applications of the QVF-9A and the QVF-9B would be on loaded and non-loaded cable, respectively. With respect to their applications, Transcom's TE-6/QVF compares to Northern's QVF-9A and Transcom's NLC/QVF compares to Northern's QVF-9B. The Commission is not in a position to evaluate the features of the units. Effective January 1, 1978, Transcom's list price for the TE-6/QVF was $105 and it was $115 for the NLC/QVF. Transcom typically discounted off list price when tendering on volume requirements. It had listed the TE-6 at $115 and quoted a price of $90 to AGT. Northern's prices to Bell, as of July 1977, after applying Bell's normal discount, were $118 and $146.

b) Loop Extenders (Power Boosters)

> "Loop extenders are used to extend central office signalling and supervision on subscriber loop plant by boosting the voltage."

As in the case of the voice frequency repeaters, Northern had developed loop extenders which formed part of the VF-300 system. Bell standardized on units in May 1976.

Transcom produces four different loop extender units. The T32A is used for ordinary voice telephone service and the T32B is used on loops to prepay coin telephones. The T32S is used on loops over which "special service" is provided, which is taken to mean that the line is used for the transmittal of data. The T32A/S may be used for either ordinary voice or special service.

Mr. Hill's comments on these units are quoted below:

> "The Transcom T32A and T32B are functionally equivalent to the Northern QVF 32A and QVF 32B.
>
> . . .
>
> The Northern 32A permits the voltage in the local loop to be boosted by either 24 or 48 volts. The Transcom 32A provides only a 48 volt boost. With only a 48 volt boost available on loops with less than 2000 ohms connected to a step-by-step office, there will be some 'bell tapping' (the bell rings as the subscriber dials) and 'pre-trip' on multi-party lines (the bell in the subscriber's telephone does not ring). The Transcom T32B application is identical to the QVF32B and has both 24 and 48 volt boost. The Northern QVF 32A and QVF 32B were developed as part of the VF300 system and were standardized May 1976. For these reasons

> standardization of the Transcom 32A and 32B was never considered when they became available later.
>
> The Transcom T32A/S is not equivalent to the Northern QVF 32A because it lacks the capability to provide normal testing of the loop circuit from the central office. These tests permit the telephone company to ascertain from the central office whether a fault is in the loop or in a telephone set, which reduces the time to repair and the cost of repairs. Bell would not normally buy a loop extender without this feature."

Although Mr. Bessette made Transcom's prices for loop extenders available to the Commission, he did not know Northern's prices and thus could not provide a comparison. As in the case of the TE-6, Mr. Bessette provided both the list price and the price used in quoting on a tender call. The T32A/S, listed at $72, was quoted in a successful bid on 1,500 units to 'edmonton telephones' at a price of $46, which is a discount of 36.2 per cent from list, and is a much deeper cut than was made in the other categories of equipment on which similar information is available. This once again illustrates that it is very difficult for Bell or anyone else to know what the lowest price is unless it is clear to suppliers that they will get the business if their price is right.

6. Remote Concentrator

Another product sold by Transcom was Lynch's electronic subscriber switching system or concentrator - the B281. Its purpose, like that of Northern's DMS-1, is to eliminate long local loops. The unit is placed in a remote location and instead of running the local loops of subscribers in the area to the central office they are connected to the concentrator, which communicates with a corresponding unit located in the central office. The saving to the telco is derived from the replacement of local loops by a smaller number of trunks. The B281 provides capacity for up to 128 subscriber circuits whose traffic is carried to the central office over a maximum of 32 trunks. Northern's DMS-1 has a capacity of 256 subscriber lines, with the traffic to the central office carried over a maximum of 48 trunks using two digital lines.

The price of the B281, according to Mr. Bessette, was $52,000, in contrast to the $100,000 price of the DMS-1. The two pieces of equipment are far from being the same; the DMS-1 is digital and the B281 is analogue. Additionally, four remote DMS-1 units can be accommodated by a single DMS-1 central office unit, whereas there is a necessary one-to-one relationship between B281 remote units and central office units. In situations where the full capacity of the DMS-1 is used and two B281 units would be required, the DMS-1 is less costly, according to the evidence. It is possible that the DMS-1 would also be less costly where four remote units were connected to a single central office unit, although one or more of the remote units was serving even fewer subscribers than could be accommodated by the B281. Nevertheless, an important question has been raised by Mr. Bessette's testimony, which is whether there are particular circumstances where the B281 provides a more cost-effective solution. Both the DMS-1 and the B281 provide the same function, and the DMS-1 may well be the best answer in most cases, but not necessarily in all. For instance, B.C. Tel purchased the B281 and its predecessor, the B280, as well as purchasing ITT's digital concentrator.

7. Test Lines for Plessey and Mitel

Mitel Corporation and Plessey Canada Limited have both been described in Part I of the Report. Representatives of both Mitel and Plessey indicated that obtaining test lines for their equipment was important to their operations. Mr. L.W. Jones, General Manager, Telecommunications, Plessey Canada Limited, indicated that there had been delays in obtaining these lines from Bell Canada. When the K-1, Plessey's electronic KTS/PBX, was developed it was field-tested in the U.S. through the co-operation of an interconnect company. Yet, of the $2 million R&D spent in developing the K-1, approximately $.75 million was obtained from the Canadian government. Mr. Jones noted that delays in obtaining test lines from Bell had restricted Plessey's export opportunities. In October 1978, Mr. Jones testified that Plessey had asked Bell to provide testing facilities approximately two years earlier, again after 12 months and again in 1978. Although Bell indicated in a letter of August 1978 that it was prepared to enter into a special agreement to allow testing of the K-1 system for a specified period of time, the period mentioned in discussions with Plessey was one to two weeks, which Mr. Jones considered inadequate. Mr. Jones later (December 1978) testified that the time period Bell agreed to would be 60 days, and that that was hardly sufficient, 12 months being preferable. He also reported that A.E.I in Winnipeg could connect their system to MTS facilities, and that Plessey had been able to connect the K-1 to the facilities of 'edmonton telephones'.

Mr. T.H. Matthews, Executive Vice-President of Mitel Corporation, indicated that close co-operation with the telco in the area of development was of assistance to manufacturers of telecommunication equipment. The first written request to Bell relating to the provision of test lines for the Mitel SX 200/PBX was a letter dated December 7, 1977, requesting installation of the PBX at the Kanata plant. After further correspondence, a special agreement was signed on August 8, 1978, which provided for a 60-day testing period, with a 30-day extension period subject to mutual agreement. It was evidently a new policy at Bell to provide test lines to companies other than Northern or BNR. An amended special agreement was entered into in January 1979. In July 1979 a special agreement authorized Mitel to install permanently an SX 200 at their plant for testing and display purposes.

Mr. Matthews stated in November 1979 that Bell was now fairly, but not completely, co-operative with Mitel. Problems still existed regarding the provision of test lines which Mr. Matthews believed were fully available to BNR and Northern Telecom on very short notice and without any requirement for formal documentation. A recent Mitel request for a rural party-type test line had been verbally turned down by Bell, and had not been discussed in more detail with that company.

CHAPTER VIII

POLICY ISSUES AND RECOMMENDATIONS

Vertical integration between telecommunication carriers and their equipment suppliers results in a restriction of trade, almost by definition. All of the circumstances surrounding the telecommunication equipment industry and the specific results of the vertically integrated operations must be taken into account in deciding whether any remedial actions are necessary, and, if they are, the form which they should take.

A key characteristic of the telecommunication equipment market is that in much of the world competition is highly restricted. Although there are technological and political pressures for greater openness in the purchasing practices of telecommunication carriers, these have not yet produced appreciable change. As set out in Chapter VI, since telcos outside of North America are almost universally owned and operated by governments, their purchasing practices have been dictated by government policies, which have generally been highly protectionist. There is little evidence of serious encouragement of price competition within these countries, and it does not appear to be an important force. Government policies in countries with a domestic telecommunication equipment manufacturing industry also influence competition for sales to developing countries. With their domestic market protected, manufacturers are able to recover the greater part of their development costs from domestic sales and may price their equipment for export* at incremental cost. Development costs are particularly high for switching equipment. This results in highly competitive conditions in the markets that are open to competition. In countries where the carriers bear much of the development costs of equipment this further reduces the costs which must be recovered by equipment manufacturers. The prices that manufacturers must charge in export markets in order to recover their full costs are also reduced by the subsidization of interest costs by governments anxious to encourage exports.

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* Exports may be components or totally assembled equipment, depending in large measure on the policy of the country to which the equipment is being sold.

These propositions are not supported by direct evidence in the form of price comparisons. Prices paid by foreign carriers are not known and cannot be compared with those charged by their suppliers in other countries. The propositions, however, are consistent with the protectionist approach of governments and the nature of domestic competition in countries relying on a domestic telecommunication equipment industry.

To this bare-bones picture must be added the trade restrictions that arise from differing technical standards. In general this factor protects domestic manufacturers but limits the markets to which they export. In the case of Canada, domestic manufacturers are not protected where Canadian and U.S. standards are the same and European or Japanese manufacturers find it worthwhile to modify their equipment for the U.S. market. In fact there are few product areas which are not affected by the presence in the U.S. of a number of European and Japanese based suppliers.

Until recent years Canadian suppliers did not incur significant development costs since equipment used in Canada was largely developed elsewhere. Additionally, most of the Canadian market was largely closed to import competition as the result of tariff barriers, technical standards that were different than those outside North America and, above all, vertical integration between Bell and Northern, and B.C. Tel and Automatic Electric. Domestic manufacturers are also favoured by the fact that telcos like to be assured of strong engineering support for their equipment, which can most easily be supplied by domestic firms with manufacturing facilities in the country. Thus any required investments in product development were secured by a high level of protection against import competition.

One matter which requires careful consideration is whether Northern could or would have proceeded with large-scale development efforts in the late 1960s and early 1970s without financial support from Bell and the shelter of a protected market. The structural variables in an industry bearing on competition which contribute to success in innovation are subject to debate. Northern's market security provided it with some breathing space to engage in expensive product development across a broad front of the telecommunication equipment industry. It is highly doubtful whether Northern or any firm in similar circumstances would have undertaken costly and, as all development projects must at bottom be, risky product development without the assurance of a large part of the Canadian market. What is less clear is what decisions would have been taken in the absence of the promise of substantial sales in the U.S. Even with the total exclusion of the AT&T and GTE telcos the remaining U.S. telco market is as large as Canada's. Northern's early success in the U.S. was in subscriber switching where the market had been opened through interconnection.

There are two fundamental questions with regard to the extent to which there should be government policy intended to foster and encourage a domestic telecommunication industry in Canada, in which product design is in large measure directed and undertaken within the country. The first involves an industry-specific question that is at the heart of any judgment on the merits of vertical integration between an operating telco and its equipment suppliers. The predominant model in most developed countries is a large degree of telco funding and control of development. Outside of North America the telcos, with few exceptions, do not own equipment supply manufacturers. But in all cases there is a close working relationship between the telcos and selected domestic equipment suppliers. In North America carrier/manufacturer vertical integration has been predominant; viz., AT&T, GTE, Bell Canada and, until fairly recently, some of the larger independent telcos in the U.S.

The issue of whether ongoing involvement of telcos in product development is required for their successful operation is clouded by the use of government ownership of telcos as an instrument to develop domestic telecommunication equipment manufacturing. Moreover, the change in technology resulting in the merging of computer and telecommunication technologies has weakened the case that may have existed earlier. However, Northern and Bell are of the view that the interface of the personnel of an operating company with that of a manufacturer and a research arm is a critical element in the success of Northern's product development. It is virtually impossible to evaluate such evidence other than by observing the success of products developed by equipment manufacturers which are not integrated with a telco. The outstanding examples have been in the area of switching, both subscriber and central office. Rolm, Mitel and Danray stand out in the area of subscriber switching and Danray, acquired by Northern, was the successful developer of tandem switches for use in private networks. Although Vidar was forced to abandon the market for central office switches and Stromberg-Carlson has incurred losses in this area, the reasons for their difficulties are not related in any obvious way to difficulties in product development because they were not affiliated with a telco. Such an affiliation would, however, have considerably increased their sales; there has never been any doubt of the benefit to an equipment supplier of having a more or less captive market.

One of the points of rebuttal by Northern to the types of examples offered above is that non-integrated manufacturers were not successful in developing "network enhancing" products, defined as technologically advanced products that facilitate future network evolution while improving existing performance. Any supplier, however, addresses the market it perceives. Firms producing telecommunication terminal equipment are likely to design equipment with features that appeal to end-users if the end-users' response to the equipment is going to be the critical feature in making sales. When suppliers are addressing the telco market, they can be expected to design equipment which meets telco needs.

The core evidence and argument in support of the value of vertical integration in the product development process reside in the information flows between a telco and its supplier. A main benefit is that the flow of information is confidential, which is important to the equipment supplier but generally not to the telco. Bell did offer a number of examples intended to demonstrate that it benefited from its relationship with Northern, in being able to influence the direction and timing of product development. This evidence is counterbalanced by examples of Bell's success in obtaining products which permitted it to offer new services with equipment developed by outside suppliers, as occurred with Dataroute and in the mobile telephone field. There are, as well, a number of examples in the inquiry of other carriers working with non-affiliated suppliers to develop equipment to specific needs.

It should be noted that such information exchanges between B.C. Tel and Automatic and Lenkurt were not an important feature in product development prior to the takeover of the Canadian subsidiaries of those companies. Based on the testimony of the witnesses for those companies there is no reason to believe that the information flows from B.C. Tel were different or more important than those from any important customer. There is little information regarding the development process following the acquisition, other than that major product development is still centred in and directed from the U.S. In these cases it is difficult to see what opportunity there is for important information flows from B.C. Tel which could aid in developing new products.

The situation of the supplier is different since its competitive position can be seriously affected if information regarding the direction of its product development and the means of its implementation are learned by its competitors. There is virtually no way for an outside body to judge the efficacy of the information exchanges between Bell and Northern in the product development process. One is thrown back on global assessments of performance, which means that it is very difficult to isolate the importance of particular factors in the success or failure of the vertical relationship.

Overall Northern has been a very successful company. Bell has contributed to this success, most obviously by providing a market and research support. Although the importance of Bell's contribution in the product development process is difficult to identify and evaluate specifically, all aspects of the vertical relationship must be considered as possible contributing factors to the overall performance of Northern. It is critical in commenting on Northern's performance to recognize that whatever vertical integration contributes, the ultimate driving force is the competition Northern faces in other markets, and primarily the relatively large U.S. market. The non-Bell Canadian markets, especially those on the Prairies, provide a partial test of Northern's competitiveness in its sales to Bell. However, they are not yet sufficiently large to create important stakes in major new product development.*

Vertical integration undoubtedly makes regulation more difficult and costly. The CRTC has been confronted with the tasks of protecting subscribers of Bell and B.C. Tel from financial risk, and from purchasing decisions which are not in their interest. While it is possible to solve the first problem there is not, unfortunately, an acceptable solution to the second.

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* While the statement in the text generally holds, Sask Tel's installation of a large fibre optics system should contribute to Northern's engineering and manufacturing expertise. Similarly, the firms participating in Alberta's cellular mobile radio system should benefit in a number of ways.

The Director's principal recommendation in the Green Book was that Northern should be divested from Bell. At the conclusion of the inquiry, the Director took the position that because of changes in circumstances, divestiture was no longer the best solution. The opening up of the terminal equipment market to competition as a result of the CRTC's interim decision* on interconnect and the move to competitive bidding by B.C. Tel were cited specifically as changing the balance in favour of another approach. The Director recommended that Bell should be required to set up a system of competitive bidding. In effect two systems were proposed, one for relatively standard equipment and another for complex systems.

In addition to the submission by the Director, final argument was also submitted by the Governments of Ontario and Quebec, and by Bell, Northern, Canada Wire and Cable and B.C. Tel. B.C. Tel and Canada Wire and Cable supported the Director's position. B.C. Tel owns an equipment supplier, and the interest of these companies, like that of many of the suppliers who appeared before the Commission, is that Bell should follow a policy of open purchasing which permits their equipment to be fairly evaluated.

Canada Wire and Cable also urged that, in the event that the Bell market was not opened to competitors of Northern, Northern should be prevented from selling wire and cable to other Canadian telcos. It took the position that, as the situation stood, there was a fundamental unfairness to other Canadian firms such as Canada Wire and Cable; Northern was free to pursue the customers of its competitors while it enjoyed practically sole access to the Bell market. This contention is undoubtedly true in some cases, but while there may be circumstances when it is in the public interest to restrict temporarily a particular firm from certain markets in order to allow viable competitors to develop, these circumstances are not present in this inquiry.

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* A final ruling was issued November 23, 1982 (CRTC 82-14).

The Governments of Ontario and Quebec expressed strong opposition to divestiture. Both briefs stressed the important role that Northern has played in providing Canada with a strong telecommunication equipment industry. The two governments were also in agreement in opposing competitive bidding. Concern was expressed that the consequences would be unfavourable to the Canadian industry and to employment as the result of the penetration of the Canadian market by multinational suppliers.

Bell and Northern took the position that vertical integration has provided Canada with a strong equipment industry and efficient telephone service, and that there is thus no reason to disturb the relationship. They argued that competitive bidding or any other means used to open up Bell procurement would have negative consequences on the ability of the integrated firm to innovate. It was also argued that, due to the presence of economies of scale and scope, if Northern lost sales as a result of competitive bidding its costs would rise.

It is appropriate to cite the conclusion of DOC on the effect of vertical integration which was expressed in its study, *The supply of communications equipment in Canada* (1981). The Department had access, of course, to the record in this inquiry.

> "While the dismantling of special relationships between certain Canadian carriers and communications equipment manufacturers could have serious adverse effects, the maintenance of such links should not deny the competitive aspirations of small autonomous manufacturers. As noted in Chapters 4 and 5, many such manufacturers have emerged or expanded in recent years and deserve encouragement. In the final analysis, the interests of these small manufacturers may not diverge that much from those of

> the large vertically integrated communications manufacturers and their associated carriers. Small manufacturers often provide products which complement those of large manufacturers while the presence of large domestic manufacturers in the home market can discourage massive assaults by foreign multinationals, thus indirectly protecting small domestic manufacturers. Yet vertically integrated and autonomous manufacturers' interests sometime conflict. Such differences can and must be reconciled in a spirit of constructive compromise, taking into account not only the long term interests of consumers and producers of communications equipment but also those of the nation as well."

The evidence in this inquiry does not establish that, on balance, the separation of Bell and Northern would improve performance in the telecommunication equipment industry or in the delivery of telecommunication services by Bell and other carriers. The record is less clear in the case of B.C. Tel. The desirability of maintaining the ownership link between B.C. Tel and AEL, however, should be evaluated in the light of any decisions made with respect to Bell and Northern. If AEL is to be a credible alternative domestic source of central office and transmission equipment in addition to Northern, AEL probably requires the marketing advantages afforded to it by its relationship with B.C. Tel. Although it is highly unlikely that AEL will be able to undertake expensive product development, it does have depth of manufacture and substantial customer service capability.

The evidence does not justify the imposition of a system of competitive bidding on Bell. There are instances when Bell's subscribers might have been better served if Bell had selected another supplier, but the vertical relationship must be judged in its entirety in deciding whether it should be disturbed. In the instances in question, Bell has perhaps been better off in the long run having waited for Northern's product improvements. While Dr. Babe's evidence on growth in productivity raises a question regarding B.C. Tel and Bell's performance, there are too many uncertainties regarding the causes of the measured differences to ascribe them to vertical integration.

The concerns of DOC quoted earlier could be dealt with by selective access of certain domestic suppliers to Bell and B.C. Tel. It would be very difficult to implement such a policy formally. If it were based on the nationality of the ownership of the selected firms it could be damaging to Canada's overall interest as a trading nation. While these limitations must be recognized, moral suasion by public authorities should be employed to ensure that B.C. Tel and Bell are receptive to innovations in Canada of non-affiliates.

For the reasons discussed in this chapter, this Commission does not believe that specific remedies are required. There are, however, a number of safeguards that should be maintained or introduced to ensure that vertical integration operates in the public interest.

Recommendations

1. Northern should be required to continue to sell to Bell at prices no higher than those offered to other Canadian customers. The requirement is very important to competing suppliers because it protects them against potential predatory pricing by Northern in the non-Bell market. Bell subscribers are also protected against higher prices than those paid by other telcos for similar equipment. The protection is only partial, however, because some of Northern's equipment may not be successful with other telcos.

2. The CRTC should require Bell and B.C. Tel to provide reports on prices of selected equipment that these companies pay to their affiliated suppliers and those that are available from other suppliers in Canada

and the U.S. As discussed in Chapter III, the CRTC had made a similar request covering equipment available in Canada. Bell had objected to this request on the ground that its investigation of the offerings of other suppliers did not allow accurate comparisons to be made. This matter is still unresolved.

It is possible to anticipate a number of objections to this recommendation since it is obvious from much of the evidence on equipment characteristics, and particularly evidence dealing with procurement criteria, that original cost to a buyer is only one consideration in choosing equipment. It is also clear from the evidence that it is difficult for a buyer to know what market prices are unless a supplier is assured that it would receive the business if it offered the best combination of price and equipment features.

These considerations and others which were raised in connection with competitive bidding must be taken into account in deciding the kind of information the telcos should be required to provide, and the uses to which the information should be put. The Commission is confident that the CRTC is in a position to ask the right questions so that meaningful responses would be obtained. While it is to be expected that, for example, the cost per line of a digital switch within a particular size range varies depending on the specific location and other factors, it should be possible to determine where, within the range, the prices paid by Bell and B.C. Tel fall. Comparisons for individual equipment items would, of course, be much easier to make than for systems. The telcos' difficulty in obtaining prices is only present for Bell, since B.C. Tel is open to offerings from a number of recognized suppliers. In addition to the information available from the telcos, the CRTC would have other information sources, including other regulatory bodies and government departments.

The purpose of gathering such information is not to second-guess management on particular procurement decisions, but is to allow the CRTC to assure itself that the ownership link with equipment suppliers is not, on average, costly to subscribers.

Implementation of this recommendation should not be onerous to Bell and B.C. Tel, nor to the CRTC. If some additional effort is required of Bell beyond that now expended in researching alternative equipment offerings, it is a necessary one. No firm operating in a competitive environment would arrive at "make or buy" decisions without good ongoing information of the prices available to it from firms outside its organization. It is reasonable to require equal diligence from regulated firms.

It should be recognized that this recommendation does not constitute a "remedy". Vertical integration by a rate-of-return regulated firm requires ongoing monitoring. Various tests of the effects of purchasing from Northern have been filed from time to time by Bell which were alternatives for the kind of monitoring being suggested. It is our view that the most effective monitoring occurs when the regulator takes the initiative in determining the type of information required.

3. B.C. Tel should maintain its procedures for open procurement. However, the Commission does not believe that the imposition of such procedures is an effective means of monitoring the purchasing decisions of integrated telcos. To do so would result in the creation of excessive rigidity in the description and selection of equipment. There is no doubt, however, that the various systems of open procurement, involving competitive purchasing, used by a number of telecommunication carriers in Canada can be effective management tools. In addition, these systems are instrumental in creating a more broadly based telecommunication equipment industry than is possible with vertical integration. It remains to be seen how B.C. Tel's stated procurement practices serve to accomplish this purpose. In the case of Bell, it must show itself more receptive to innovations which are developed in Canada by non-affiliated companies.

4. It would clearly be in the public interest for there to be better understanding of the causes of differences in telco tariff levels, which is a critical area of telco performance. Improved understanding of comparative telco performance would not only contribute to a better appreciation of the effects of vertical integration, but could also contribute in a significant way to other public policy concerns. A good first step could be made if a uniform system of cost accounting were implemented. This would require close co-operation of the provincial regulatory bodies and the CRTC. The latter's cost inquiry should provide a constructive background to any efforts that might be undertaken. Telcos are likely to find themselves facing increasing competition from other carriers and from private systems in the provision of both old and new services. Public policy concerns over the possibility of cross-subsidization of the competitive services by the monopoly services are likely to arise and will require improved knowledge of the carriers' cost structures nationwide.

5. Since the mandate of the CRTC is to protect the interests of subscribers, should it decide that, on average, equipment obtained from affiliated suppliers was too costly, it would be faced with a dilemma if there were national goals in place which could best be achieved through vertical integration. Under such circumstances, it would be desirable that the Government issue guidelines to the regulator to assure that these goals are taken into account.

Commissioner

Commissioner

Ottawa

January 7, 1983